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Utah Surface Gamma-Ray Scanner Survey

Bendix Field Engineering Corp.
Grand Junction, CO

Prepared for

Office of Radiation Programs-Las Vegas
Facility, NV

Jun 82

U.S. Department of Commerce
National Technical Information Service
NTIS

PB83-195693

BFEC-1982-7

UTAH SURFACE GAMMA-RAY SCANNER SURVEY

June 1982

Bendix Field Engineering Corporation

Grand Junction Operations
Grand Junction, CO 81502

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BIBLIOGRAPHIC INFORMATION

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The U.S. Environmental Protection Agency (EPA) conducted a radiation survey of public and private buildings in the vicinity of mineral mining areas to establish the use, if any, of radioactive mineral waste materials in any phase of construction. The survey was conducted in two phases. The initial phase utilized a mobile van equipped with radiation detection instrumentation to survey radioactive levels in the vicinity of the structures of interest. Areas or structures which indicated higher than normal background levels of radiation were recorded for further investigation. The second phase of the survey involved detailed on-site radiation studies to locate and identify the source of radioactivity and to make appropriate radiation measurements inside the structures to provide an assessment of health impacts.

KEYWORDS: *Radioactivity, *Gamma rays, *Radioactive wastes, *Construction materials, *Utah.

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UTAH

SURFACE GAMMA-RAY SCANNER SURVEY

JOHN WAYNE ALLEN

Bendix Field Engineering Corporation
Project Operations Division
Grand Junction, Colorado

June 1982

Prepared for the U.S. Environmental Protection Agency
Office of Radiation Programs - Las Vegas Facility
Las Vegas, Nevada 89114
Under Interagency Agreement EPA 80-D-X-1013
with U.S. Department of Energy
Grand Junction Area Office
Grand Junction, Colorado 81502

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ABSTRACT

The U.S. Environmental Protection Agency (EPA) conducted a radiation survey of public and private buildings in the vicinity of mineral mining areas to establish the use, if any, of radioactive mineral waste materials in any phase of construction. The survey was conducted in two phases. The initial phase utilized a mobile van equipped with radiation detection instrumentation to survey radioactive levels in the vicinity of the structures of interest. Areas or structures which indicated higher than normal background levels of radiation were recorded for further investigation. The mobile survey van remained on public roads and thoroughfares during these surveys, except when a survey was specifically requested by an owner of remote private property. The radiation detection equipment was typically capable of detecting an anomaly as far away as approximately 150 feet. While the mobile survey system would detect an area of increased radioactivity, it could not identify the source of the radioactivity. The radiation source could have been a pile of radioactive rocks in a yard, a stone facing on a house, or a house foundation consisting of radioactive materials.

The second phase of the survey involved detailed on-site radiation studies to locate and identify the source of radioactivity and to make appropriate radiation measurements inside the structures to provide an assessment of health impacts. This second phase was referred to as the follow-up phase and utilized a two-person team to perform the various radiation measurements. The follow-up team surveyed only those structures where owner permission had been granted.

Both phases of the survey were performed by the Bendix Field Engineering Corporation (Bendix) of Grand Junction, Colorado.

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1.0 INTRODUCTION

The Utah Surface Gamma-Ray Scanner Survey was funded through an interagency agreement between the Office of Radiation Programs, U.S. Environmental Protection Agency (EPA), and the Grand Junction Area Office, U.S. Department of Energy (DOE). Bendix Field Engineering Corporation (Bendix), a DOE contractor, provided project management, technical expertise, and field-experienced personnel.

1.1 Background

Mobile gamma-ray scanning surveys were conducted in the vicinity of uranium mills as early as November 1970. Lucius Pitkin, Inc., in compliance with a request from the U.S. Atomic Energy Commission, conducted surveys in 100 cities and towns in 10 western states, namely Arizona, Colorado, Idaho, New Mexico, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. The project was subsequently funded by the U.S. Environmental Protection Agency from August 1971 to September 1972.

The Utah Surface Gamma-Ray Scanner Survey was conducted to detect the presence of radioactive materials from mine wastes as compared to radioactive materials from mill tailings. A potential health hazard could exist if mine wastes were used for construction purposes. Mine waste could have been used as sand aggregate, landfill, landscaping, or ballast.

Field surveys began July 14, 1980, and ended June 10, 1981. The survey excluded those cities and towns surveyed in the 1970-1972 project. A greater emphasis in this 1980-1981 survey was placed on rural homes and businesses. Survey areas were located near mining activities which may have produced waste materials with elevated levels of radioactivity.

1.2 Radiological Health Hazards

Two abundant radioactive elements, uranium and thorium, are routinely mined by the nuclear industry. As the ore is mined and milled, radioactive waste is produced. The waste material contains parent elements and daughter products of the uranium and thorium decay chains. Ultimately the daughter products will decay into stable isotopes of lead. The principal isotopes which cause exposure problems to man are thorium-230, radium-226, radon-222, and radon-222 daughter products.

Exposure can be both internal and external. Thorium-230 and radium-226 can enter the body through the inhalation of windblown dust or the ingestion of contaminated food or water. Radium-226 is soluble and can be removed from the waste material and enter the environment.

Radon-222 is an inert mobile gas. Its half-life of 3.82 days allows ample time for the gas to enter the atmosphere and migrate from its source. Radon and its daughter products may be inhaled into the body. In the lungs, radon daughters emit alpha and beta particles, and gamma rays. Externally, the body may be exposed to whole-body gamma radiation from radionuclides in the waste material.

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1.3 Program Format

The first step in the survey of public and private structures consisted of a mobile scanner van survey to determine the presence of radioactive anomalies. The location of anomalies was reported to the EPA Project Officer. Since only extensive follow-up activities could determine the nature of the anomaly, the EPA Project Officer then obtained permission to study the anomalous property. Once permission was received from the property owner, a follow-up study was conducted to determine the actual source of the radioactivity. Due to time and budget constraints, however, no follow-up surveys were conducted in Utah.

2.0 EQUIPMENT

A special van was used to carry radiation detection equipment, spare parts, and follow-up survey instruments. Gamma radiation was detected by both a scintillation crystal and a pressurized ion chamber (PIC). Gamma readings were continuously recorded on an analog strip-chart recorder for a permanent record and for future reference.

2.1 Survey Van

Two separate mobile gamma-ray scanner vans were used in this survey. The vans were identified as EPA-01 and EPA-02, and were used interchangeably in the county surveys. Van EPA-01 was installed with the detector systems described by Hans and others, in the publication, Above Ground Gamma-Ray Logging for Locating Structures and Areas Containing Elevated Levels of Uranium Decay Chain Radionuclides.

The equipment discussed in this report will refer to the equipment located in Van EPA-02. Van EPA-02 (Figure 1) was a large commercially available van installed with a Bendix-engineered detector system. Modifications to the van included insulation, windows, heater, and air conditioners. The van, with its 14'2"-length, 8'6"-width, and 6'5"-height interior, served as a mobile laboratory. Ample room existed to carry interested observers, spare equipment, follow-up instruments, and luggage required for extended periods of field work.

The interior of Van EPA-02 (Figure 2) contained comfortable captain's chairs and large view windows to aid the equipment operator. The equipment operator was responsible for recording street address or location as the van passed anomalous properties. A storage cabinet was installed in the van to store extra recorder charts and supplies. An auxiliary gas tank was added to extend field time between refuelings.

2.2 Detection Systems

A thallium-activated sodium iodide [NaI(Tl)] crystal was the heart of the gamma detection system. The crystal was in the shape of a rectangular prism measuring 4 inches x 4 inches x 16 inches. Operating on the scintillation principle, this detector was capable of detecting gamma energies in the 0.1 to 3.0 million electron volt (MeV) range.

Figure 1. Surface Gamma-Ray Scanner Van

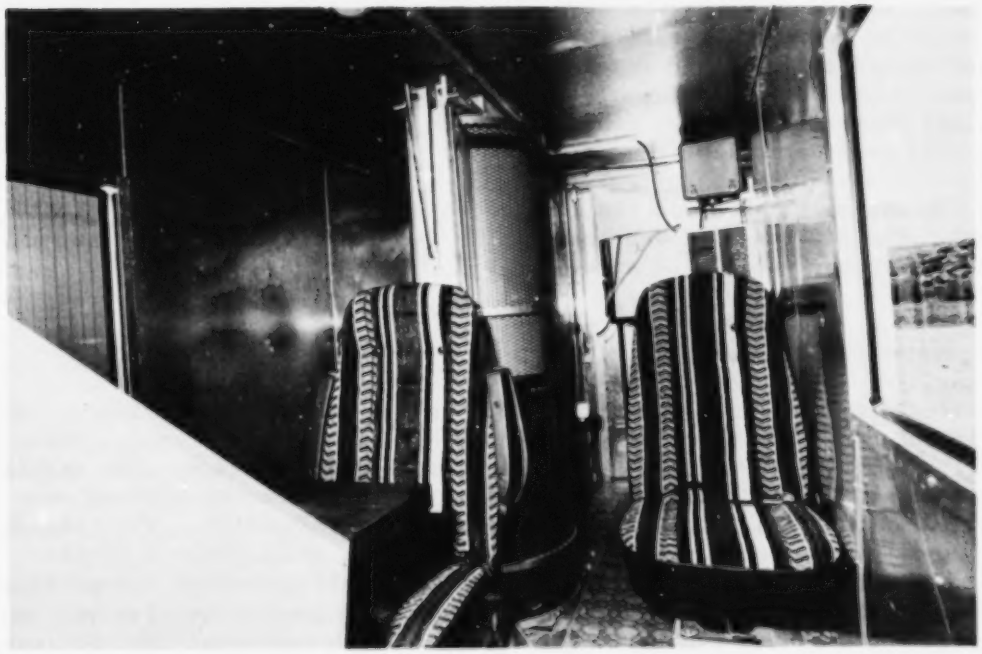

Figure 2. Interior View of the Surface Gamma-Ray Scanner Van

The detector had to be shielded or collimated to interpret the direction of the gamma source. The detector was mounted with its long axis vertical and shielded on three sides with copper and lead shot. The detector assembly was essentially able to "view" through an elliptical cone (Figure 3) and could be called unidirectional in nature. The elliptical cone had a horizontal spread of 50 degrees and a vertical spread of 80 degrees.

The entire detector assembly was mounted on adjustable, rotatable elevators (Figures 4 and 5) so that it could be raised or lowered to meet operating conditions. The detector window was 48 inches above the road surface in the lowered position and 79 inches in the raised position. The detector was operated in the raised position when surveying and could then "see" over parked cars or earth levees between van and property. Typically, the detection equipment could survey properties 50 to 150 feet from the road. To lower the van's center of gravity, the detector was lowered when traveling at highway speeds.

The detector was normally set to view the right-hand side of the road. To view in any other direction, the assembly could be rotated 360 degrees. To protect the crystal from physical shock and temperature changes, the crystal photomultiplier assembly was packed with rigid foamed-in-place polyurethane.

A second van-mounted detection system incorporated an omnidirectional pressurized ionization chamber (PIC). The PIC was mounted in the left-hand rear corner of the van (Figure 6). The omnidirectional characteristics of the PIC offered a counterbalance to the unidirectional scintillation crystal. Normally when an anomaly was observed, both the PIC and the NaI detector recorded an increase in radiometric activity. However, in some cases, the PIC would record an increased reading whereas the NaI detector did not. This situation indicated the anomaly was not within the collimated view window of the NaI detector. The van would then turn around and survey the other side of the road in order to locate the source.

The PIC was calibrated and recorded in exposure units (microroentgens per hour). The PIC readings were especially useful in establishing the radiometric backgrounds of an area.

2.3 Recording Systems

The recording console was designed for maximum operator convenience. All equipment controls were easily reached from the operator's chair. Voltage monitors, both alternating current (AC) and battery voltage, were displayed in digital readouts. Instrument modules and spare instrument modules were mounted in a NIM bin located above the recorder (Figure 7). The recording system used commercially available units: Topaz model 5312-26 static inverter, Ortec 276 photomultiplier base with self-contained integrating preamplifier, Canberra model 3002 regulated NIM bin-mounted high voltage power supply, Nuclear Data type 512 amplifier/single-channel analyzer, Nuclear Data type 776 linear ratemeter, and Hewlett-Packard model 7132-A analog recorder.

The strip-chart recorder recorded two channels of information (Figure 8). All NaI detector responses were recorded in counts per second (cps). Normally full-scale response was from 0 to 500 cps or from 0 to 1000 cps. The

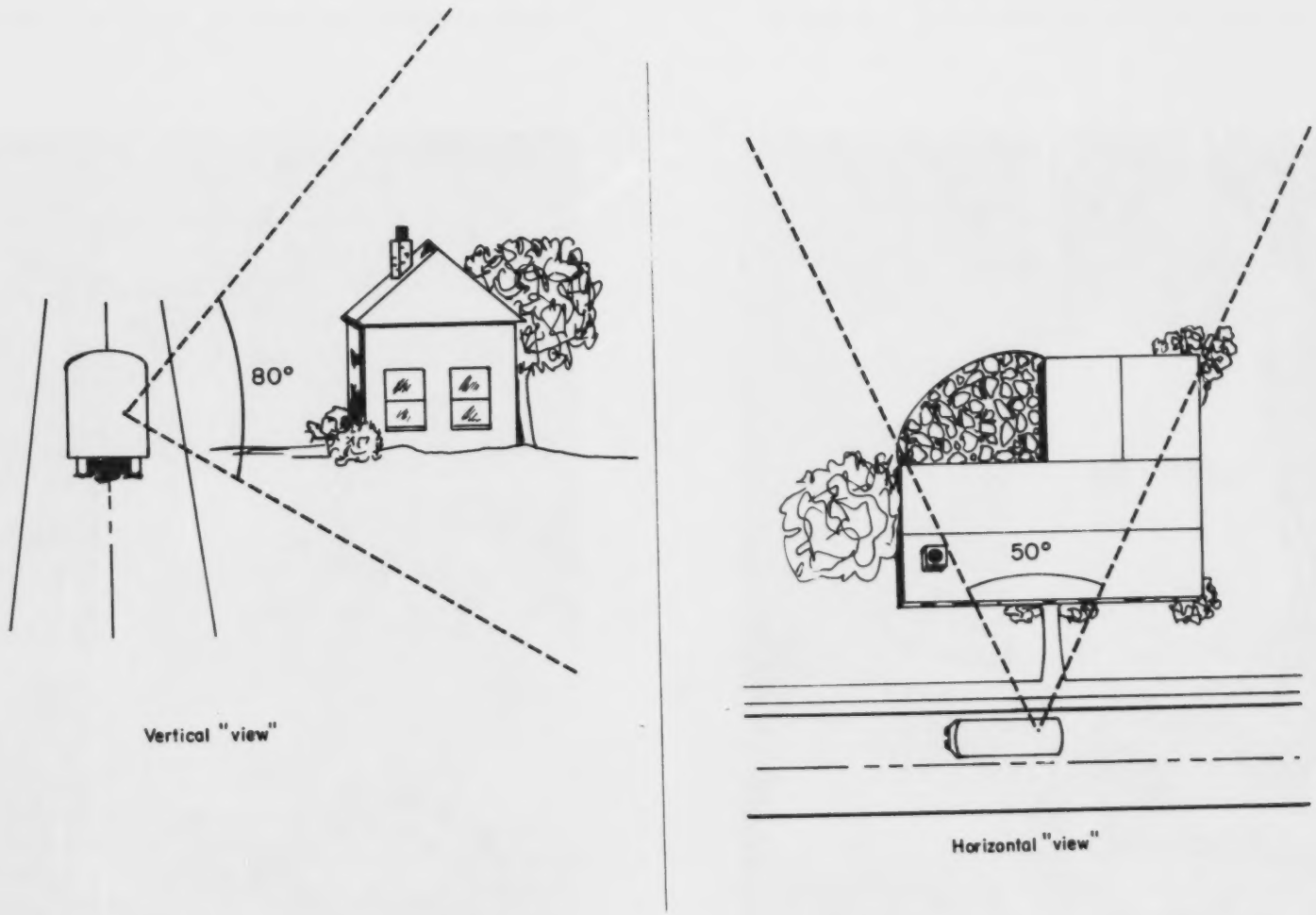

Figure 3. Elliptical "View" of the NaI(Tl) Detector Assembly

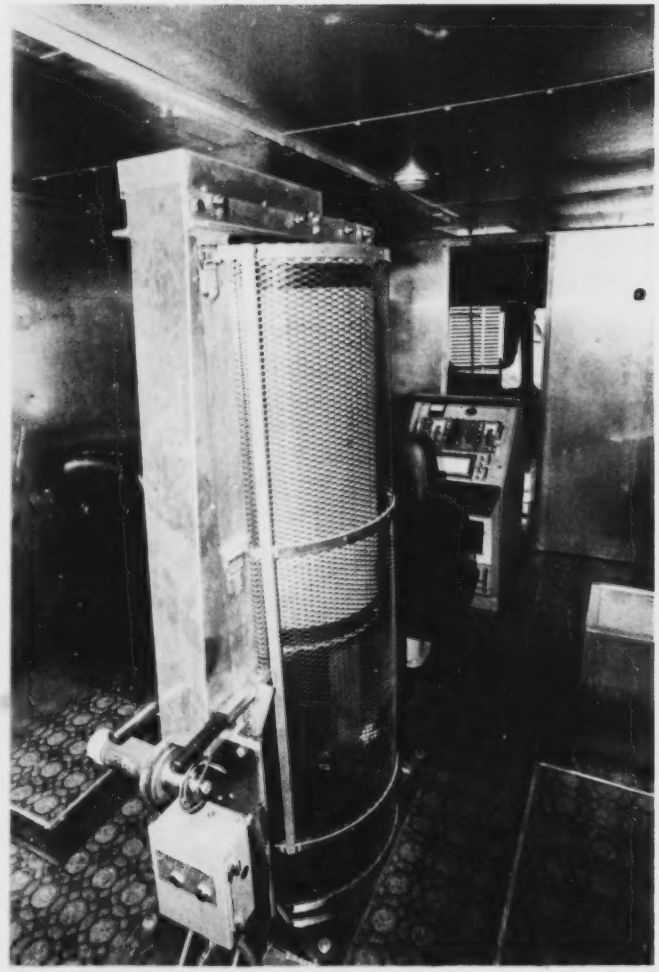

Figure 4. NaI(Tl) Detector Assembly Mount

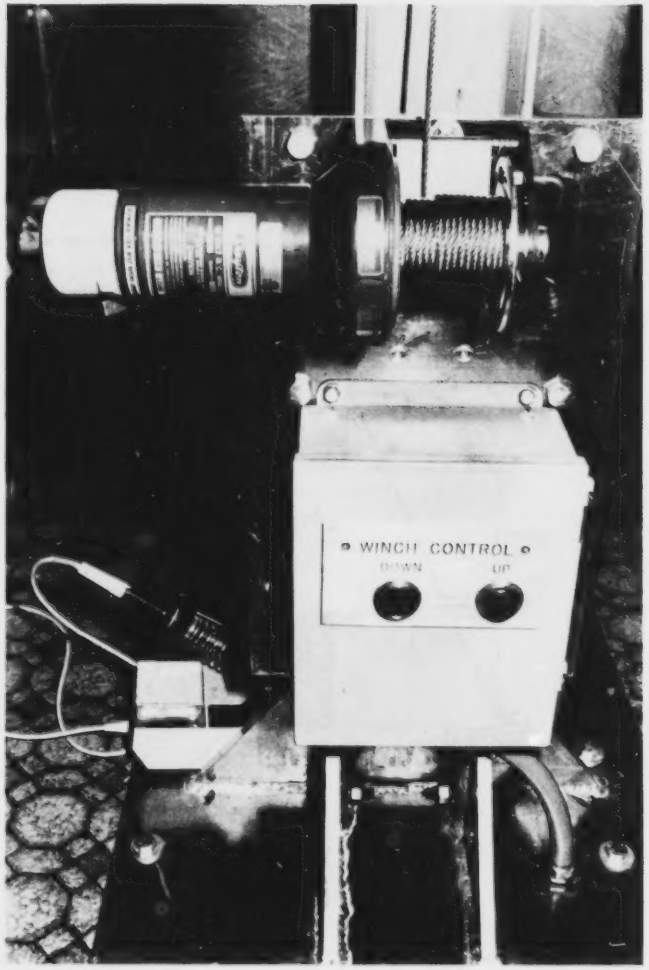

Figure 5. Winch Control for the NaI(Tl) Detector Assembly Mount

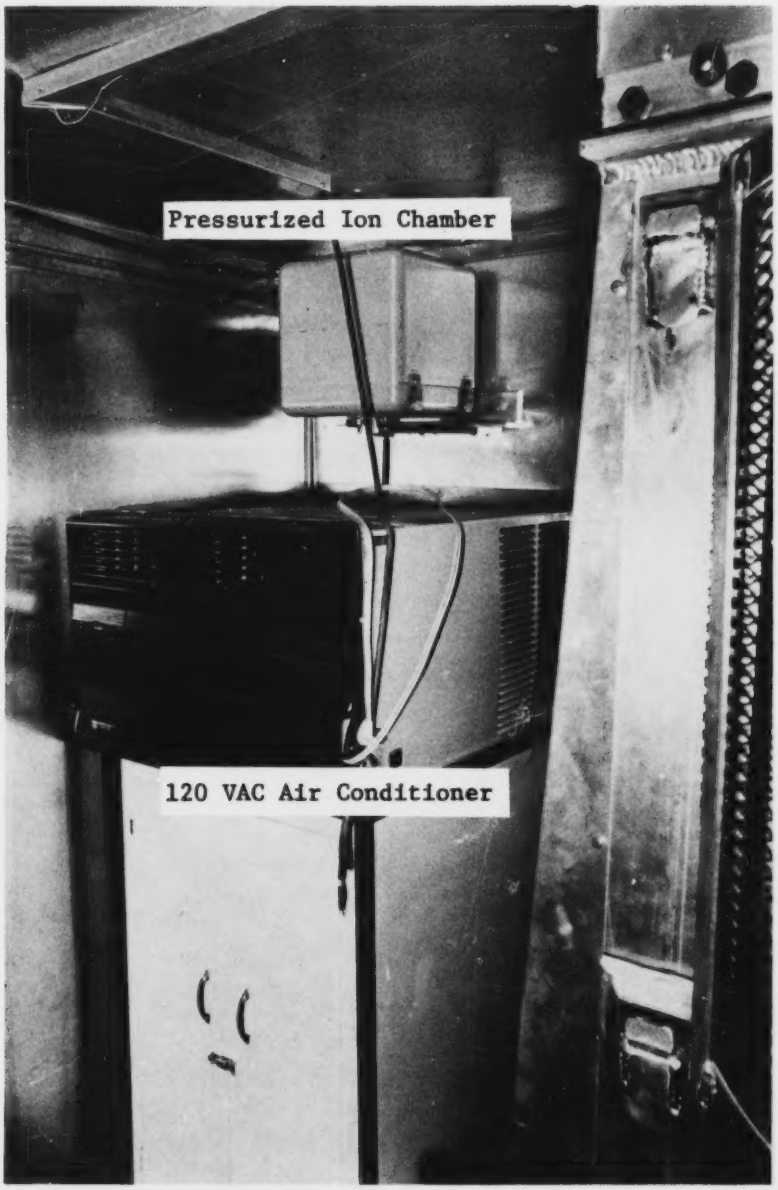

Figure 6. Pressurized Ion Chamber (PIC) Detector

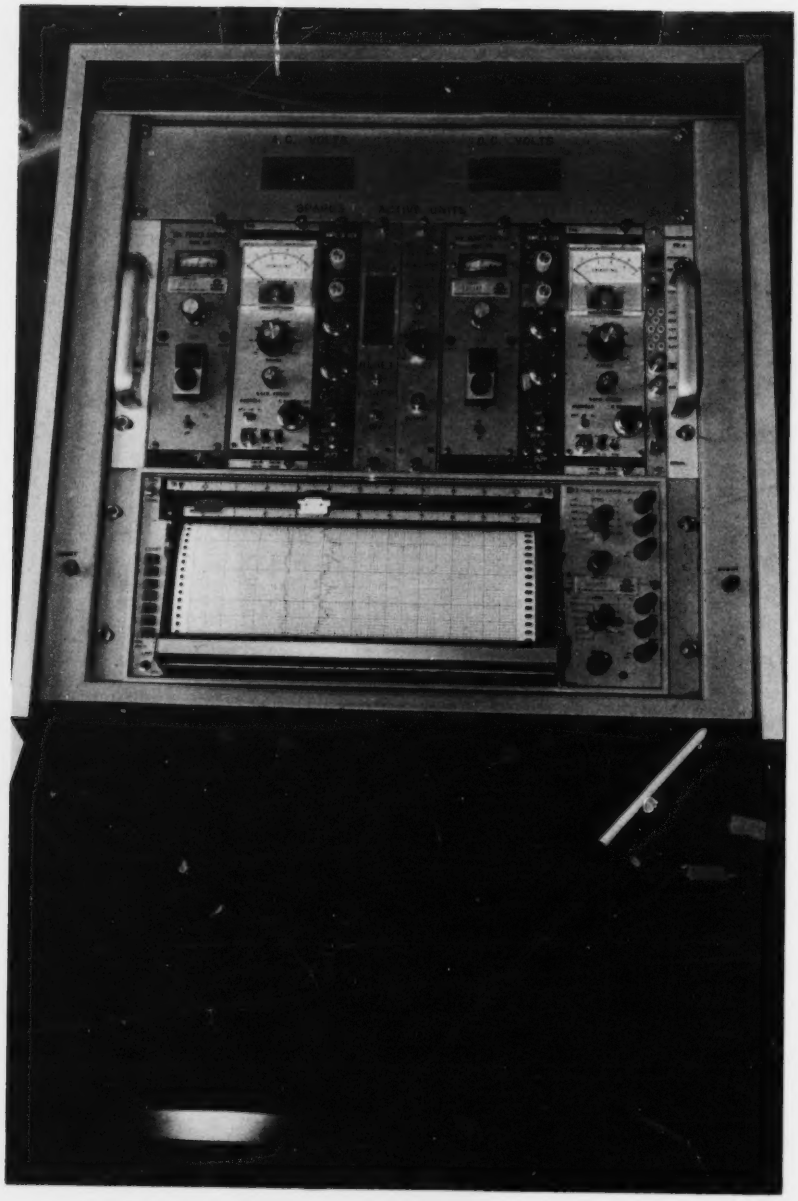

Figure 7. Operator Console in the Surface Gamma-Ray Scanner Van

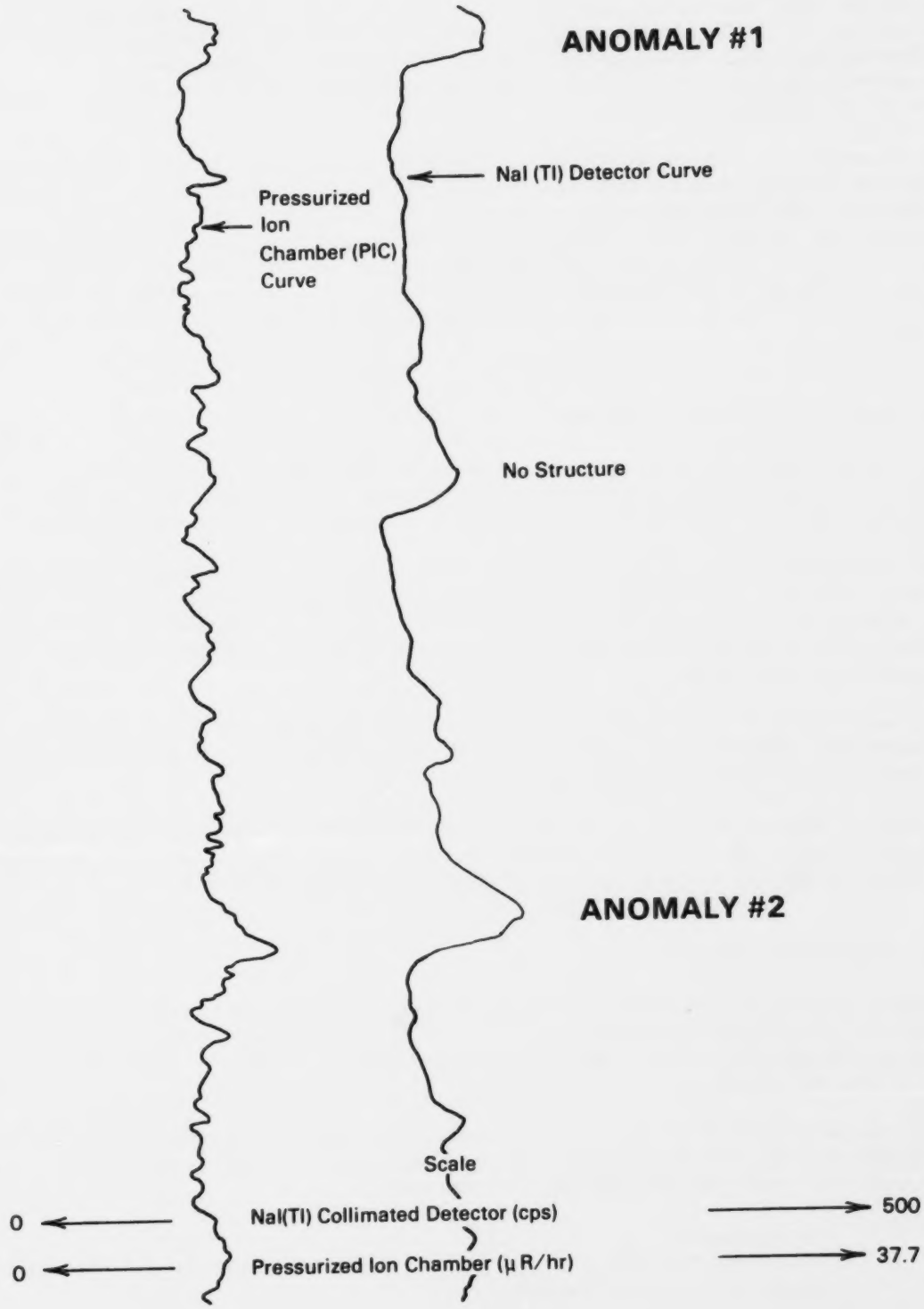

Figure 8. Analog Recorder Strip

ratemeter input was calibrated by use of a pulse generator capable of delivering 100, 500, 1K, 5K, 10K, or 50K cps. Recorder calibration was rechecked with each scale change. The PIC response was recorded in microroentgens per hour (μR/hr). Typically the PIC was run on a full scale of 0 to 18.85 μR/hour.

The recorder was driven by either an internal or external drive. The operator selected the function (either internal or external) most suited to the field situation. The internal drive provided 1, 2, 3, 4, or 6 inches of chart movement per minute, or 1, 2, 3, 4, or 6 inches per hour. The external drive coupled vehicle movement to chart movement. One inch of recorder chart movement equaled a whole-number multiplier times 34.7 feet of vehicle travel. Multipliers (1, 2, 3, ... etc.) were selected by a thumb-wheel switch mounted in the NIM bin.

2.4 Heating and Cooling Systems

The van was equipped with two heating systems and two cooling systems. Temperature control was important to provide for stable operation of the instrumentation. Temperature control also provided for operator comfort.

When surveying on hot days, a standard automobile air conditioning system was used to cool the van interior. An auxiliary cooling outlet was installed in the rear of the van to further distribute air flow. A 110-volt alternating current (AC)-powered air conditioner was used when the van was stationary and AC power was available.

Heat was provided by both the van hot-water radiator heater and a propane recreational vehicle (RV) heater. The RV heater could be run independently or in conjunction with the engine heater.

Details on system design, performance specifications, hardware descriptions, and performance tests for the van and its components were documented by James W. Allen in EPA-02 Surface Scanner System, Report No. BFEC-1981-7.

3.0 SCANNING TECHNIQUES

Counties scheduled for scanning contained either active or inactive uranium mines, or mines with a radioactive by-product. To optimize both time and funding limitations, only a generalized sampling of roads and towns in each county was surveyed.

Field crews consisted of two-person teams. The crew members alternated duties as driver and equipment operator. Responsibilities of each crew member included, but were not limited to, the following:

- Equipment Operator
  1. Operated system and verified the performance of electronic equipment through calibration checks.
  2. Identified radiometric anomalies.
  3. Recorded street address or location of the anomalous property.
  4. Counted the number of structures surveyed.
  5. Recorded mileage and elapsed time of the daily survey.

- Driver
  1. Exercised caution and safety while driving.
  2. Maintained a constant 10-mph vehicle speed during survey.
  3. Advised the equipment operator of approaching intersections and identified roads and streets.
  4. Assisted the equipment operator in identifying street addresses.

Upon completion of a week's survey, the field crews prepared a written summary of the field results. Figures 9, 10, and 11 are the forms used for this purpose. The Weekly Progress Report summarized the number of anomalies located, number of structures surveyed, miles surveyed, and time required for each county surveyed. The Summary Report repeated the same information but for an individual county. The totals on the Summary Report could cover several surveys throughout the county over a period of several weeks. The Anomaly Report was completed if an anomaly was located in the county. Appendix A provides the Utah County Summary and Anomaly Reports for counties surveyed in Utah. Appendix B contains county maps marked with survey routes, anomaly locations, and known uranium mines.

3.1 Definition of Anomaly

The equipment operator had to identify radiometric anomalies quickly and accurately. An anomaly was considered to be any reading which had a value greater than background plus 2 times the square root of the background:

$$\text{Anomaly} = \text{Background} + 2\sqrt{\text{Background}}$$

Baseline readings from the recorder chart were considered the same as the background reading for anomaly identification purposes.

3.2 Utah Anomalies

Table 1 summarizes the anomalies found in the Utah Surface Gamma-Ray Scanner Survey. A total of 268 anomalies were found in the 8477 structures surveyed. On an average, 3.16 percent of the structures surveyed were anomalous. It should be noted that these 268 anomalies were only those anomalies that the scanner van was able to identify. Some of the structures surveyed may contain anomalies hidden by virtue of distance or shielding.

4.0 FOLLOW-UP PROCEDURES

The mobile scanner survey discovered 268 anomalous locations in Utah. Because of time and budget constraints, no anomalous locations were selected for detailed on-site radiological measurements. Ideally, each anomaly in Utah should have been investigated for possible health hazards. Investigation of these properties will depend on future funding and future projects.

A specially trained follow-up crew was prepared to perform radon grab sampling and gamma mapping, as needed, at each selected anomalous location. The grab-sample findings could be used to determine radon and radon progeny concentrations in terms of working levels (WL).

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Grand Junction Operations

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MOBILE RADIATION SURVEY
WEEKLY PROGRESS REPORT

FROM _____ **TO** _____

Locations Surveyed County/State	Number Anomalies Located	Number Structures Surveyed	Miles Surveyed	Survey Time
TOTALS				

Remarks:

BFEC 1366
6 6 80

Figure 9. Weekly Progress Report Form

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SUMMARY REPORT: MOBILE RADIATION SURVEY

_____ County, _____

County Completed	_____
Survey Begin	_____
Survey End	_____
Radiation Anomalies Located	_____
Structures Surveyed	_____
Miles Surveyed	_____
Survey Time	_____

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Figure 10. Summary Report Form

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MOBILE RADIATION SURVEY
ANOMALY REPORT

_____ County, _____

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment

BFEC 1365
6 6 80

Figure 11. Anomaly Report Form

Table 1. Anomaly Summary by County

County	Map No.	Anomalies Found	Structures Surveyed	Miles Surveyed	Survey Time (hours)
Emery	121 - 122	2	1319	99	5
Garfield	130 - 134	11	406	415	9.5
Kane	135 - 136	5	912	136	4
Piute	127	10	297	74	6
San Juan	18-19,27	59	810	56	12
Sanpete	125 - 126	32	1808	195	14.5
Sevier	123 - 124	139	2549	263	19.5
Wayne	128 - 129	10	376	136	7
UTAH TOTALS		268	8477	1374	77.5

If follow-up surveys had been conducted, gamma maps would be used to define the property areas containing radioactive material. Knowledge of how the material was used could be useful in future recommendations for remedial action. No remedial action was performed or intended to be performed under the scope of this project.

Both a hand-held scintillometer and pressurized ionization chamber (PIC) would be used in the gamma mapping. Typically, scintillometer measurements would be recorded on 10-foot centers and PIC measurements on 20-foot centers.

Five measurements could be made at any sample point:

1. PIC reading 3 feet above the ground.
2. PIC reading at ground contact.
3. Scintillometer reading 3 feet above the ground.
4. Scintillometer reading at ground contact (open contact).
5. Scintillometer reading at ground contact with lead shield placed between ground and meter detector (closed contact).

The following legend could be incorporated to differentiate between the various measurements:

$$\boxed{\frac{76.1}{78.4}} = \frac{\text{3-foot PIC Reading}}{\text{Ground PIC Reading}}$$

$$\frac{17}{18.5} = \frac{\text{3-foot Scintillometer Reading}}{\text{Open Contact Scintillometer Reading}}$$

$$\frac{13.5}{18.5} = \frac{\text{Closed Contact Scintillometer Reading}}{\text{Open Contact Scintillometer Reading}}$$

$$13.5 \quad \frac{17}{18.5} = \text{Closed Contact Scint. Rdg.} \quad \frac{\text{3-foot Scintillometer Reading}}{\text{Open Contact Scintillometer Rdg.}}$$

The open or closed scintillometer measurements could also be recorded for wall surfaces as well as ground or floor surfaces.

5.0 SUMMARY

The Utah Surface Gamma-Ray Scanner System has proven to be a cost-effective method of radiation detection. The effectiveness of the system must be measured in terms of both the surveying cost per structure and the detection of anomalies. The alternative to mobile scanning would be a door-to-door, property-by-property, hand-held scintillometer survey. The time and cost factors for such a survey would be overwhelming.

In the 1970-to-1972 mobile survey, the mobile scanner was only able to detect 85 percent of the anomalies discovered by hand-held scintillometers. On the other hand, the mobile scanner identified anomalies missed entirely with hand-held meters. The mobile scanner may miss radioactive materials that are (1) shielded by large earth coverings; (2) small, weak, or distant radioactive accumulations; or (3) weak anomalies within a high background area.

Readings from the mobile scanner are not quantitative in nature. The unknown factors of radioactive mass and distance allow only for qualitative interpretation. An experienced operator could recognize an anomaly not only by its peak reading but also by the shape or character of the strip-chart curve.

The techniques and equipment developed in the Utah Surface Gamma-Ray Scanner Survey have several practical applications. First, most county surveys were run on a representative cross section of roads and homes. Counties exhibiting either a large number of anomalies or a large percentage of anomalies could be surveyed in greater detail. Second, none of the 268 Utah anomalies have had any follow-up work performed. The 268 anomalies could be investigated to determine the cause of the anomalous readings. Third, the mobile scanning techniques could be used to monitor industrial sites where radioactive products or materials are used or stored. The present equipment is capable of detecting lost logging sources, radioactive chemical spills, or radioactive shielding leaks.

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APPENDIX A

SUMMARY REPORTS FOR UTAH COUNTIES

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SUMMARY REPORT: MOBILE RADIATION SURVEY

Emery County, Utah

County Completed	4-20-81
Survey Begin	4-20-81
Survey End	4-20-81
Radiation Anomalies Located	2
Structures Surveyed	1319
Miles Surveyed	99
Survey Time	5 hrs

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6/6/80

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Emery County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-20-81	1	121	94		LDS church Main St.	170	220	Ferron, UT
4-20-81	2	121	94		Rd. cut on N. Center St.	190	285	Castledale, UT

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6 6 80

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SUMMARY REPORT: MOBILE RADIATION SURVEY

Garfield County, Utah

County Completed	4-27-81
Survey Begin	4-24-81
Survey End	4-27-81
Radiation Anomalies Located	11
Structures Surveyed	406
Miles Surveyed	415
Survey Time	9.5 hrs

BFEC 1364
6/6/80

Bendix Field Engineering Corporation
Grand Junction Operations

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Garfield County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-24-81	1	130	99		Ω of Main & 4th North	305	350	Panguitch, UT
4-24-81	2	130	99		Main st. So. bnd. between 1st N. & Center	300	370	Panguitch, UT
4-24-81	3	130	99		LDS Church on 6th S.	300	350	Panguitch, UT
4-24-81	4	130	99		1st house So. of 25 Main St.	310	380	Panguitch, UT (brick)
4-24-81	5	130	99		Block btwn Main & 2nd E. on Center	310	350	Panguitch, UT
4-24-81	6	130	99		Old stone bldg so. of Colored Cntry	310	385	Panguitch, UT
4-25-81	7	130	99		Texaco & Ruby's Inn Nat'l Park Rd.	240	320	Bryce Canyon area
4-25-81	8	131	99		Abandoned bldg W. of LDS Church	210	240	Tropic, UT (Cinder block)
4-25-81	9	131	99		House end of eastern most N-S st.	240	275	Cannonville, UT (W. side of st.)
4-25-81	10	132	99		Griffin's Grocery SW corner of Hwy 12	250	290	Escalante, UT
4-25-81	11	132	99		Brick home W. side Hwy 12 .3 miles from state recreation bldg.	250	290	Boulder Town, UT

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6 6 80

Bendix Field Engineering Corporation
Grand Junction Operations

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SUMMARY REPORT: MOBILE RADIATION SURVEY

Kane County, Utah

County Completed	4-25-81
Survey Begin	4-25-81
Survey End	4-25-81
Radiation Anomalies Located	5
Structures Surveyed	912
Miles Surveyed	136
Survey Time	4 hrs

BFEC 1364
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Bendix Field Engineering Corporation
Grand Junction Operations

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SUMMARY REPORT: MOBILE RADIATION SURVEY

Kane County, Utah

County Completed	4-25-81
Survey Begin	4-25-81
Survey End	4-25-81
Radiation Anomalies Located	5
Structures Surveyed	912
Miles Surveyed	136
Survey Time	4 hrs

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Bendix Field Engineering Corporation
Grand Junction Operations

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Kane County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-25-81	1	135	100		LDS Church Main St.	240	285	Glendale, UT
4-25-81	2	135	100		Clydes Market Main St.	210	250	Orderville, UT
4-25-81	3	135	100		So. side last paved E-W St.	230	285	Orderville, UT
4-25-81	4	135	100		Fisher's rock & gems; So. on 89	275	335	Orderville, UT
4-25-81	5	135	100		State Bank E. end of Main St.	220	260	Kanab, UT

REC 1385
6-6-80

Bendix Field Engineering Corporation
Grand Junction Operations

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SUMMARY REPORT: MOBILE RADIATION SURVEY

Piute County, Utah

County Completed	4-24-81
Survey Begin	4-23-81
Survey End	4-24-81
Radiation Anomalies Located	10
Structures Surveyed	297
Miles Surveyed	74
Survey Time	* 6 hrs

* Time includes field samples collected at old A.E.C. station.

BFEC 1364
6/6/80

Bendix Field Engineering Corporation
Grand Junction Operations
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MOBILE RADIATION SURVEY
ANOMALY REPORT

Piute County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-23-81	1	127	97		Abandoned store "Marysvale Merc."	640	710	Marysvale, UT
4-23-81	2	127	97		Marysvale Community Church	640	690	Marysvale, UT
4-23-81	3	127	97		Last house on paved part; Bullion Rd	620	770	Marysvale, UT (West side)
4-23-81	4	127	97		Last house No. side Bullion Rd.	560	745	Marysvale, UT (East side)
					old ore buying station for A.E.C.			
4-23-81	5	127	97		Historic Bldg., Stone, on Main St.	580	670	Marysvale, UT
4-23-81	6	127	97		Lucy Deluke's shed (old AEC Station)	1000	3100	Marysvale, UT
4-23-81	7	127	97		Piute high school (brick)	280	330	Junction, UT
4-23-81	8	127	97		Service station on Main Street	270	320	Junction, UT
4-23-81	9	127	97		Stone 2 story Bldg. SE corner of	300	390	Kingston, UT
					main drag			
4-23-81	10	127	97		White stucco home, So. side of Main	290	330	Circleville, UT

BFEC 1365
6 6 80

Bendix Field Engineering Corporation
Grand Junction Operations

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SUMMARY REPORT: MOBILE RADIATION SURVEY

San Juan County, Utah

County Completed	9-15-80
Survey Begin	8-15-80
Survey End	9-15-80
Radiation Anomalies Located	59
Structures Surveyed	810
Miles Surveyed	56
Survey Time	12 hrs

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6 6 80

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MOBILE RADIATION SURVEY
ANOMALY REPORT

San Juan County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
8-15-80	1	18	9		House 1 mi. N of Oljeto	170	190	Owner - Bud Haycock
8-15-80	2	19	9		Raymond Frank House	185	245	2 miles east of Hwy 163 on Eagle Rock Wash
8-15-80	3	19	9		Propane Tank	275	295	Indian Housing Project
8-15-80	4	19	9		Abandoned Service Station	400	445	1 mile S.W. of Mexican Hat.
					City of Monticello			
9-15-80	5	27	23		89 N. Main St.	300	450	Western Auto Store
9-15-80	6	27	23		White Brick Bldg. Next to Barber Shop	300	575	Main Street
9-15-80	7	27	23		Old San Juan Electric Bldg.	320	530	Main Street
9-15-80	8	27	23		Vacant field south of Minerals West Venture Bldg. at 46 S. Main	340	625	
9-15-80	9	27	23		92 S. Main St.	325	430	Halken, Inc.
9-15-80	10	27	23		232 S. Main St.	320	375	
9-15-80	11	27	23		290 S. Main St.	370	450	Westerner Trailer Park
9-15-80	12	27	23		391 S. Main St.	450	1400	J.B. Grain & Bean Co.
9-15-80	13	27	23		241 S. Main St.	430	460	
9-15-80	14	27	23		18 N. Main St.	350	650	U.S. Post Office
9-15-80	15	27	23		22 N. Main St.	350	635	Montgomery Ward Agency

BFEC 1305
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MOBILE RADIATION SURVEY
ANOMALY REPORT

San Juan County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
9-15-80	16	27	23		88 N. Main St.	350	405	San Juan County Courthouse
9-15-80	17	27	23		320 N. Main St.	330	415	
9-15-80	18	27	23		165 N. 1st W. St.	350	660	Trailer Home
9-15-80	19	27	23		Vacant lot-West side of 2nd W.	325	435	North of 2nd S.
9-15-80	20	27	23		154 N. 2nd W. St.	320	430	Red brick house
9-15-80	21	27	23		Two houses West of the Robert Turri residence	330	420	Oak Heights Subdivision
9-15-80	22	27	23		395 Oak Crest	335	420	
9-15-80	23	27	23		One house east of 295 Oak Crest	330	430	
9-15-80	24	27	23		Concrete driveway N. of 235 Blue Mtn. Drive	360	480	
9-15-80	25	27	23		House S.W. corner of Parkview and Oak Heights	360	480	Brown brick house
9-15-80	26	27	23		Vacant lot on E. side of North Creek Drive	360	420	
9-15-80	27	27	23		Hansen house on Silverstone	360	550	
9-15-80	28	27	23		Vacant lot on W. side of Silverstone	360	630	
9-15-80	29	27	23		Second house from Abajo Dr. on E. side of Silverstone	400	535	Alpine design home w/circular window over door
9-15-80	30	27	23		Third house S. from Abajo Dr. on W. side of Silverstone West.	330	405	

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MOBILE RADIATION SURVEY
ANOMALY REPORT

San Juan County, Utah

Date	Event No.	Map No	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
9-15-80	31	27	23		Silverstone West	350	490	
9-15-80	32	27	23		Open field N. of Cedar Lane	360	450	
9-15-80	33	27	23		Shed at 1st N. St. & 2nd E. St.	400	440	
9-15-80	34	27	24		House on N.W. corner of 2nd E. &	415	475	
					Center St.			
9-15-80	35	27	24		House on S.W. corner of 2nd E. &	450	600	
					1st S. St.			
9-15-80	36	27	24		House on N.W. corner of 2nd E. &	550	650	
					2nd S. St.			
9-15-80	37	27	24		S.E. corner of 2nd E & 1st S. St.	450	560	Part of Blue Mtn. Meats
9-15-80	38	27	24		House on N.W. corner of 3rd St. E.	405	690	
					& Center St.			
9-15-80	39	27	24		Pink house on E side of 3rd St.E.	420	480	
9-15-80	40	27	24		96 W. 4th. N. St.	350	415	
9-15-80	41	27	24		Apartments located near 1st E. &	380	515	
					3rd N. St.			
9-15-80	42	27	24		House on S.E. corner of 1st E. &	370	415	
					3rd N. St.			
9-15-80	43	27	24		210 E. 3rd N. St.	400	690	Demar Perkins Residence
								Ore car display
9-15-80	44	27	24		Gravel fill in side road	410	545	

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MOBILE RADIATION SURVEY
ANOMALY REPORT

San Juan County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
9-15-80	45	27	24		Second house from the S.W. corner	350	430	
		27			of 1st W. and 1st N. St.			
9-15-80	46	27	24		119 N. Main	350	420	Monticello Mercantile
9-15-80	47	27	24		House on S.W. corner of the extreme	415	505	White house with "Toy Box"
					west end of Center St.			written on garage
9-15-80	48	27	24		Red brick house on the east end of	400	1525	Cobblestone fence
					Abajo Drive			
9-15-80	49	27	24		White house on S.W. corner of 1st W	380	440	
					and 1st S. St.			
9-15-80	50	27	24		Steel sheds below 3rd E. & 1st S.St	600	750	
9-15-80	51	27	24		White house on N.W. corner 3rd E &	480	545	
					1st S. St.			
9-15-80	52	27	24		Trailer house on N.W. corner of	450	510	
					2nd E & 1st S St.			
9-15-80	53	27	24		Back lot of Halken, Inc	390	500	
9-15-80	54	27	24		White house on N. side of 1st S.	400	500	
					between 2nd W. & 3rd W. St.			
9-15-80	55	27	24		Grey house on S.E. corner of 2nd E.	550	790	
					& 2nd S. St.			
9-15-80	56	27	24		House on S.W. corner of Uranium Dr.	380	475	
					& 1st W. St.			

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MOBILE RADIATION SURVEY
ANOMALY REPORT

San Juan County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
9-15-80	57	27	24		White house on S.E. corner of S. Uranium and 2nd W. St.	370	435	
9-15-80	58	27	24		House on N.W. corner of S. Uranium and 2nd W. St.	375	430	
9-15-80	59	27	24		174 Circle	375	485	

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Bendix Field Engineering Corporation
Grand Junction Operations

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SUMMARY REPORT: MOBILE RADIATION SURVEY

Sanpete County, Utah

County Completed	4-22-81
Survey Begin	4-21-81
Survey End	4-22-81
Radiation Anomalies Located	32
Structures Surveyed	1808
Miles Surveyed	195
Survey Time	14.5 hrs

BFEC 1364
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Bendix Field Engineering Corporation
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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sanpete County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-21-81	1	125	96		Brick church and brick shed; turn west off Hwy 89 at Post Office	230	350	Axtell, UT
4-21-81	2	125	96		Gunnison High School, Hwy 89	210	285	Gunnison, UT
4-21-81	3	125	96		Market of Hwy 89, So. of High School	210	260	Gunnison, UT
4-21-81	4	125	96		Valley Furniture, Hwy 89	220	275	Gunnison, UT
4-21-81	5	125	96		LDS church west on 89 on Center St.	220	280	Brick; Gunnison, UT
4-21-81	6	125	96		Block on Hwy 89 between Center St. & 2nd West	230	315	Gunnison, UT
4-21-81	7	125	96		City Hall, 1st South	210	255	Gunnison, UT
4-21-81	8	125	96		Gunnison Elementary School & parking lot, Hwy 89	230	370	Gunnison, UT
4-21-81	9	125	96		301 & 375 Hwy 89	200	260	Lg brick houses, Manti, UT
4-21-81	10	125	96		215 - 2nd South	200	250	Manti, UT
4-21-81	11	125	96		Manti Lumber SE corner 89 & 1st S.	200	255	Brick, Manti, UT
4-21-81	12	125	96		South Sanpete school District bldg and Zion 1st National Bank and parking lot, Hwy 89	210	310	Brick, Manti, UT
4-21-81	13	125	96		North side of 100 blk of 1st N.	200	250	Manti, UT
4-21-81	14	125	96		Chief Pontiac Car Co., NE corner of 89 and 2nd North	210	250	Manti, UT
4-21-81	15	125	96		Brick school 5th West, west of LDS temple	200	340	Manti, UT

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sanpete County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-21-81	16	125	96		Abandoned chapel W. side of Main, No. side of town	210	260	Manti, UT
4-21-81	17	125	96		Auto Parts and Nells Motor, Main St. between 1st N. and Union St.	210	315	Manti, UT
4-21-81	18	125	96		102 & 107 Main	230	370	Manti, UT
4-21-81	19	125	96		Corner of Main & 2nd S.	250	310	Ephraim, UT
4-21-81	20	125	96		Ephraim Bank	270	320	Ephraim, UT
4-21-81	21	125	96		Cafe on SE corner of Main & 3rd N.	250	290	Ephraim, UT
4-21-81	22	125	96		West side of 100 block of Main	255	320	Ephraim, UT
4-21-81	23	125	96		Town Movie Theatre & NW corner Center & Main	250	350	Brick, Ephraim, UT
4-21-81	24	125	96		Public Library	260	310	Ephraim, UT
4-21-81	25	125	96		Ranger station, Main St.	270	315	Brick, Close to detector, Ephraim, UT
4-21-81	26	125	96		Jr. High School practice field, SE corner State & Main	300	355	Mt. Pleasant, UT
4-21-81	27	125	96		0-99 block Main & block between 100 South & Main on State	300	370	Mt. Pleasant, UT
4-21-81	28	125	96		Movie Theater, Mortuary, Museum, State St.	300	360	Mt. Pleasant, UT
4-21-81	29	125	96		Chevron station , corner Hwy 89 & 100 South	310	350	Fairview, UT

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sanpete County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-21-81	30	126	96		Brick bldg. No. of P.O. on State & Nelson Grocery	330	400	Fairview, UT
4-21-81	31	126	96		Unoccupied brick bldg between 100 S. and Center on State	300	390	Close to detector Fairview, UT
4-21-81	32	126	96		Brick business bldgs, North of GMC dealer & used cars on State	320	380	Fairview, UT

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Bendix Field Engineering Corporation
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SUMMARY REPORT: MOBILE RADIATION SURVEY

Sevier County, Utah

County Completed	4-23-81
Survey Begin	4-15-81
Survey End	4-23-81
Radiation Anomalies Located	139
Structures Surveyed	2549
Miles Surveyed	263
Survey Time	19.5 hrs

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Bendix Field Engineering Corporation
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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sevier County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-21-81	1	123	95		Mom's cafe and Pamela's Movie Theater Main St.	325	390	Salina, UT
4-21-81	2	123	95		280 Main	300	365	Salina, UT
4-21-81	3	123	95		470 East 1st	320	385	Salina, UT
4-21-81	4	123	95		50 East 2nd; trailer	315	365	Salina, UT
4-21-81	5	123	95		Lot and house E. of 210 E. 2nd St.	320	390	Salina, UT
4-21-81	6	123	95		Garden west of 377 East 2nd St.	310	375	Salina, UT
4-21-81	7	123	95		Trailer Court on So. side of 3rd North, east bound	300	375	Salina, UT
4-21-81	8	123	95		West side of 100 block of 1st East	300	380	Salina, UT
4-21-81	9	123	95		0 to 90 block of 1st East	300	350	Brick homes, Salina, UT
4-21-81	10	123	95		East side of 100 & 200 block of 1st East	300	390	Brick homes, Salina, UT
4-21-81	11	123	95		48, 54, 78 2nd East	300	345	Brick homes, Salina, UT
4-21-81	12	123	95		Lot no. of 49 2nd East	300	350	Salina, UT
4-21-81	13	123	95		4th house from the NE corner of 4th East and 3rd South; traveling No. on 4th East	350	430	Brick house, Salina, UT
4-21-81	14	123	95		489 East 2nd South	300	500	Salina, UT
4-21-81	15	123	95		White brick home to E. of 389 East 2nd South	300	380	Salina, UT
4-21-81	16	123	95		451 E. 1st S. & house E. of 451	320	430	6' bank in front of houses

BFEC 1365
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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sevier County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-21-81	17	123	95		Auto Parts Store on Hwy 89	310	415	Salina, UT
4-21-81	18	123	95		2 houses No. of 91st West	300	375	Brick, Salina, UT
4-21-81	19	123	95		Utah Turkey Growers, Sandy Lane	300	405	Cinder Block Bldgs.
4-21-81	20	123	95		327 and 337 Sandy Lane	360	420	New Apt. Bldgs, Salina, UT
4-21-81	21	123	95		390 South 1st West or State St.	360	465	Old, Yellow, Brick, Salina
4-21-81	22	123	95		Municipal Bldg and Library, North side of Main St. West	360	400	Salina, UT
4-21-81	23	123	95		2 doors east of 270 Main	360	430	Red Brick Commercial bldg.
4-21-81	24	123	95		Salina Senior Citizen's Center	350	410	Salina, UT
4-21-81	25	123	95		Salina Feed and Supply, Main St.	300	365	Salina, UT
4-21-81	26	123	95		Premium Oil Gas Station, Main St.	300	410	Salina, UT
4-21-81	27	123	95		Midway Diesel, Main St.	300	360	Salina, UT
4-21-81	28	123	95		Wasatch Motel, Main St.	300	360	Brick, Salina, UT
4-21-81	29	123	95		7-11 Gas Station and Store, Main St.	320	390	Brick, Salina, UT
4-21-81	30	123	95		320, 330, 370, 390 3rd North	300	340	Brick, Salina, UT
4-21-81	31	123	95		Lot south of 65-4th West	320	380	Salina, UT
4-21-81	32	123	95		Salina High School, 1st West	310	390	Brick, Salina, UT
4-21-81	33	123	95		City Pool and Fire Dept; NE corner 1st West and Main	310	440	Brick, Salina, UT
4-21-81	34	123	95		Rick's Burgers, Hwy 89, So. end of town	300	435	Salina, UT
4-21-81	35	123	95		1st National Bank of Salina Main & Hwy 89	360	450	Salina, UT

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sevier County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-22-81	36	124	95		Aurora Mercantile, LDS church, Sorenson's Food Market	380	470	Aurora, UT
4-22-81	37	124	95		Bastion's Service, No. side of the main street	360	420	Close to Detector; Cinder block, Aurora, UT
4-22-81	38	124	95		First group of houses on the south side of the main street traveling eastbound before the first right	320	390	Aurora, UT
4-22-81	39	124	95		965 State St.	380	365	Green stucco house, Sigurd
4-22-81	40	124	95		House so. of the LDS church on 900	280	370	Sigurd, UT
4-22-81	41	124	95		85 State St. and abandoned wooden Filling Station	310	360	Sigurd, UT
4-22-81	42	124	95		185 Center St.	260	310	Sigurd, UT
4-22-81	43	124	95		300 Main	280	330	Sigurd, UT
4-22-81	44	124	95		160 Main	270	370	Sigurd, UT
4-22-81	45	124	95		Sigurd Center & Conoco and 70 Main and State St.	290	395	Sigurd, UT
4-22-81	46	124	95		Sigurd town hall, graveled lot to so. of town hall, & 95 State St.	340	390	Sigurd, UT
4-22-81	47	124	95		Trihiggins Co. Hwy 89E.	330	440	Richfield, UT
4-22-81	48	124	95		540-600 E. & Field no. of 540	295	335	Richfield, UT
4-22-81	49	124	95		Homes to the no. and including the house on the NE corner of 500 E. & 300 N.	300	380	Richfield, UT

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sevier County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-22-81	50	124	95		Garden so. of 569-500 East	300	370	Brick, Richfield, UT
4-22-81	51	124	95		Wood house so. of 435-300 N., and 407-300 N.	310	380	
4-22-81	52	124	95		535 400 East	310	380	Brick, Richfield, UT
4-22-81	53	124	95		307, 347, 375 - 300 North	310	385	Brick Homes, Fertilizer present; Richfield, UT
4-22-81	54	124	95		New Housing development end of 300 East	300	440	Richfield, UT
4-22-81	55	124	95		2nd brick house so. of house on the SW corner of 500 N. and 300 E.	300	350	Richfield, UT
4-22-81	56	124	95		245-300 North and houses to the East and West	315	385	Richfield, UT
4-22-81	57	124	95		Yellow brick house so. of 440-200 E	320	365	Richfield, UT
4-22-81	58	124	95		25 and 95 700 North	370	440	Richfield, UT
4-22-81	59	124	95		0-200 blocks of N. Main, West side	350	500	Richfield, UT
4-22-81	60	124	95		Safeway, South Main	350	485	Richfield, UT
4-22-81	61	124	95		Alman's Grocery, South Main	350	425	Richfield, UT
4-22-81	62	124	95		Dennings Hardware & a tire Co., South Main	330	430	Richfield, UT
4-22-81	63	124	95		Martensen Finance and Parking lot to the South	330	415	Richfield, UT
4-22-81	64	124	95		525 So. Main	370	415	Richfield, UT

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4-6-81

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sevier County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-23-81	65	124	95		Drive-in with no name	370	415	Richfield, UT
4-23-81	66	124	95		Maverick Country Store, 100 block	370	430	Richfield, UT
					South Main			
4-23-81	67	124	95		0-99 block, South Main	400	500	Richfield, UT
4-23-81	68	124	95		Pharmacy and Floral shop 0-99 block	400	480	Richfield, UT
					North Main			
4-23-81	69	124	95		Richfield Bank, 100 blk N. Main	400	510	Richfield, UT
4-23-81	70	124	95		County Court House, 200 blk N. Main	400	490	Richfield, UT
4-23-81	71	124	95		West side of 300 and 400 block of	370	420	Richfield, UT
					North 100 West			
4-23-81	72	124	95		1st 2 houses on West side of 200	370	430	Richfield, UT
					block of North 100 West			
4-23-81	73	124	95		West side of 500 block of 100 West	300	370	Richfield, UT
4-23-81	74	124	95		Utah Highway Patrol, N. 100 West	300	450	Richfield, UT
4-23-81	75	124	95		Back of Safeway and brick house to	335	405	Richfield, UT
					North, 100 West			
4-23-81	76	124	95		190-100 West	320	380	Richfield, UT
4-23-81	77	124	95		Utah Highway Patrol, 200 West	300	405	Richfield, UT
4-23-81	78	124	95		Brick church on SE corner of center	330	445	Richfield, UT
					and 200 West and Elementary school			
					north of church			
4-23-81	79	124	95		Brick & Stone houses on 700 & 800	340	430	Richfield, UT
					block of Upland Drive			

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sevier County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-23-81	80	124	95		Vacant lot west of 2 brick houses	400	450	Richfield, UT
					So. of 890 Upland Drive			
4-23-81	81	124	95		600 and 700 block of Valley View	300	420	Richfield, UT Brick Homes
4-23-81	82	124	95		West side of 200, 300, and 400 block	290	380	Richfield, UT
					of North 300 West			
4-23-81	83	124	95		40-300 West	320	395	Richfield, UT
4-23-81	84	124	95		546-300 West and structure to south	315	360	Richfield, UT
4-23-81	85	124	95		740-300 West	315	375	Richfield, UT
4-23-81	86	124	95		East side of 700 block of S. 300 W.	315	385	Richfield, UT
4-23-81	87	124	95		East side of 0-99 block of N. 300 W.	320	380	Richfield, UT
4-23-81	88	124	95		East side of 400 block of N. 300 W.	320	365	Richfield, UT
4-23-81	89	124	95		Brick church on 100 block of 400 W.	350	435	Richfield, UT
4-23-81	90	124	95		No. end of the west side of the 200	360	410	Richfield, UT
					block of 400 West			
4-23-81	91	124	95		Empty lot at So. end of the W. side	360	405	Richfield, UT
					of the 300 block of 400 West			
4-23-81	92	124	95		434-400 West and houses to N & S	360	410	Richfield, UT
4-23-81	93	124	95		Urcy Bell Apts. and cultivated field	340	420	Richfield, UT
					to No. on 400 West			
4-23-81	94	124	95		East side of 600 block of 500 West	370	440	Richfield, UT
4-23-81	95	124	95		Parking lot of brick church on SE	335	405	Richfield, UT
					corner of 200 North & 500 West			

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sevier County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-23-81	96	124	95		257 - 100 East	295	340	Old Brick; Richfield, UT
4-23-81	97	124	95		1st Security Bank and Parking lot	305	430	Richfield, UT
					on 100 East			
4-23-81	98	124	95		340 - 200 East	310	365	Richfield, UT
4-23-81	99	124	95		Brick LDS church on SE corner of	305	370	Richfield, UT
					Center and 200 East			
4-23-81	100	124	95		House on SE corner of 200 S. & 300 E	295	355	Yellow Brick; Richfield, UT
4-23-81	101	124	95		House on NW corner of 100 S. & 400 E	305	370	Richfield, UT
4-23-81	102	124	95		Intermountain Farmers Garage, SE	300	390	Cinder Block; Richfield, UT
					corner of 100 S. & 400 E.			
4-23-81	103	124	95		Phillips 66; SW corner of Center &	310	450	Tile, Richfield, UT
					500 East			
4-23-81	104	124	95		Peterson Plumbing and supply; SE	310	400	Richfield, UT
					corner of 100 N. & 600 E			
4-23-81	105	124	95		Utah Social Services center 100 blk	305	390	Richfield, UT
					of 500 North			
4-23-81	106	124	95		1st Baptist Church, Main & 500 N.	305	365	Richfield, UT
4-23-81	107	124	95		School on corner of 300 W. & 500 N.	305	410	Richfield, UT
4-23-81	108	124	95		540-500 N. & field at end of 500 N.	325	410	Richfield, UT
4-23-81	109	124	95		South side of 400 blk of 500 N.	325	420	Richfield, UT
4-23-81	110	124	95		South side of 200 block of 500 N.	325	400	Richfield, UT
4-23-81	111	124	95		South side of 500 block of 300 N.	350	430	Richfield, UT

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sevier County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-23-81	112	124	95		North side 0-99 block of 200 N.	340	430	Richfield, UT
4-23-81	113	124	95		Anderson Floral 200 N. & 300 W.	365	420	Richfield, UT
4-23-81	114	124	95		367-100 North	325	405	Richfield, UT
4-23-81	115	124	95		Richfield Savings, 100 N. & Main	355	620	Richfield, UT
4-23-81	116	124	95		Back of High School	360	445	Richfield, UT; Brick
4-23-81	117	124	95		South side of 0-99 block of 100 N.	350	480	Richfield, UT
4-23-81	118	124	95		Gas station at the E. end of Center Street	385	440	Richfield, UT
4-23-81	119	124	95		Bargain Barn, corner of Center & Main	390	480	Richfield, UT
4-23-81	120	124	95		Church on 100 block of Center	385	440	Richfield, UT
4-23-81	121	124	95		Valley Central Bank; corner of Center & Main	385	490	Richfield, UT
4-23-81	122	124	95		Corner of 100 S. and Main	365	490	Richfield, UT
4-23-81	123	124	95		South side of 300 block of 100 S.	350	415	Richfield, UT
4-23-81	124	124	95		Mountain Bell bldg, 100 South	380	450	Richfield, UT
4-23-81	125	124	95		SW corner of 200 S. & 500 W.	375	460	Richfield, UT
4-23-81	126	124	95		Presbyterian church and Jones Glass and Insulation 200 S. & Main	360	410	Richfield, UT
4-23-81	127	124	95		100 block of 500 South	365	460	Richfield, UT
4-23-81	128	124	95		Apartments on NW corner of 500 S. & 200 W.	365	460	Richfield, UT
4-23-81	129	124	95		Brick church, S. side of the main st.	390	460	Annabella, UT

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Sevier County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-23-81	130	124	95		South side of first block East of church on the main street.	390	490	Annabella, UT
4-23-81	131	124	95		Service station on North side of the main street	400	440	Annabella, UT
4-23-81	132	124	95		Last brick house on north side of the main street	410	480	Annabella, UT
4-23-81	133	124	95		Uninhabited stone bldg east end of town on N. side of the main street	400	475	Elsinore, UT
4-23-81	134	124	95		Two stone bldgs (general store) North of P.O.	400	550	Elsinore, UT
4-23-81	135	124	95		So. side of 100 block of Main	400	475	Elsinore, UT
4-23-81	136	124	95		Cultivated field and stone bldg behind cafe so. of P.O.	430	530	Elsinore, UT
4-23-81	137	124	95		LDS church on Main st. SE of P.O.	430	550	Stone; Elsinore, UT
4-23-81	138	124	95		Large yellow brick house on So. side of Main St. before 1st intersection east bound on Main St.	390	450	Elsinore, UT
4-23-81	139	124	95		Area No. and So. and including country church antiques, Hwy 89	550	690	Sevier, UT

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SUMMARY REPORT: MOBILE RADIATION SURVEY

Wayne County, Utah

County Completed	4-26-81
Survey Begin	4-26-81
Survey End	4-26-81
Radiation Anomalies Located	10
Structures Surveyed	376
Miles Surveyed	136
Survey Time	7 hrs

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MOBILE RADIATION SURVEY
ANOMALY REPORT

Wayne County, Utah

Date	Event No.	Map No.	Rec. Chart No.	Tape No.	Address or Location	Bkg γ CPS	Peak γ CPS	Comment
4-26-81	1	128	98		Amoco station on Hwy 24	240	305	Torrey, UT
4-26-81	2	128	98		Chuck Wagon Motel	270	355	Torrey, UT
4-26-81	3	128	98		Produce & Grocery Store	360	420	Lyman, UT
4-26-81	4	128	98		Stone church	480	555	Loa, UT
4-26-81	5	128	98		Briron Farm Service	500	540	Loa, UT
4-26-81	6	128	98		Allreds Motel	470	520	Loa, UT
4-26-81	7	128	98		LDS Church	470	620	Loa, UT
4-26-81	8	128	98		Capitol Reef Natl Park visitor center	330	390	10 miles E. of Torrey
4-26-81	9	129	98		House on SE corner of Ω of 2nd & 24	250	315	Hanksville, UT
4-26-81	10	129	98		Junkyard & Hotel NW corner of 1st street parallel to Hwy 24	260	375	Hanksville, UT

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APPENDIX B

UTAH COUNTY MAPS

County maps and strip-recorder charts for the entire gamma-ray scanner survey were numbered sequentially as field crews surveyed various states and counties. Only Utah county maps are presented in this report. The strip-recorder charts are on file in the EPA Office of Radiation Programs, Las Vegas Facility, Las Vegas, Nevada. The maps presented in this appendix show, where appropriate, survey routes, anomaly locations, mine locations, and mining districts.

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Figure B1.	Emery County, Map No. 121, Chart No. 94	59
Figure B2.	Emery County, Map No. 122, Chart No. 94	61
Figure B3.	Garfield County, Map No. 130, Chart No. 99	63
Figure B4.	Garfield County, Map No. 131, Chart No. 99	65
Figure B5.	Garfield County, Map No. 132, Chart No. 99	67
Figure B6.	Garfield County, Map No. 133, Chart No. 99	69
Figure B7.	Garfield County, Map No. 134, Chart No. 99	71
Figure B8.	Kane County, Map No. 135, Chart No. 100	73
Figure B9.	Kane County, Map No. 136, Chart No. 100	75
Figure B10.	Piute County, Map No. 127, Chart No. 97	77
Figure B11.	San Juan County, Map No. 18, Chart No. 9	79
Figure B12.	San Juan County, Map No. 19, Chart No. 9	81
Figure B13.	San Juan County, Map No. 27, Chart Nos. 23-24	83
Figure B14.	Sanpete County, Map No. 125, Chart No. 96	85
Figure B15.	Sanpete County, Map No. 126, Chart No. 96	87
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Figure B17.	Sevier County, Map No. 124, Chart No. 95	91
Figure B18.	Wayne County, Map No. 128, Chart No. 98	93
Figure B19.	Wayne County, Map No. 129, Chart No. 98	95

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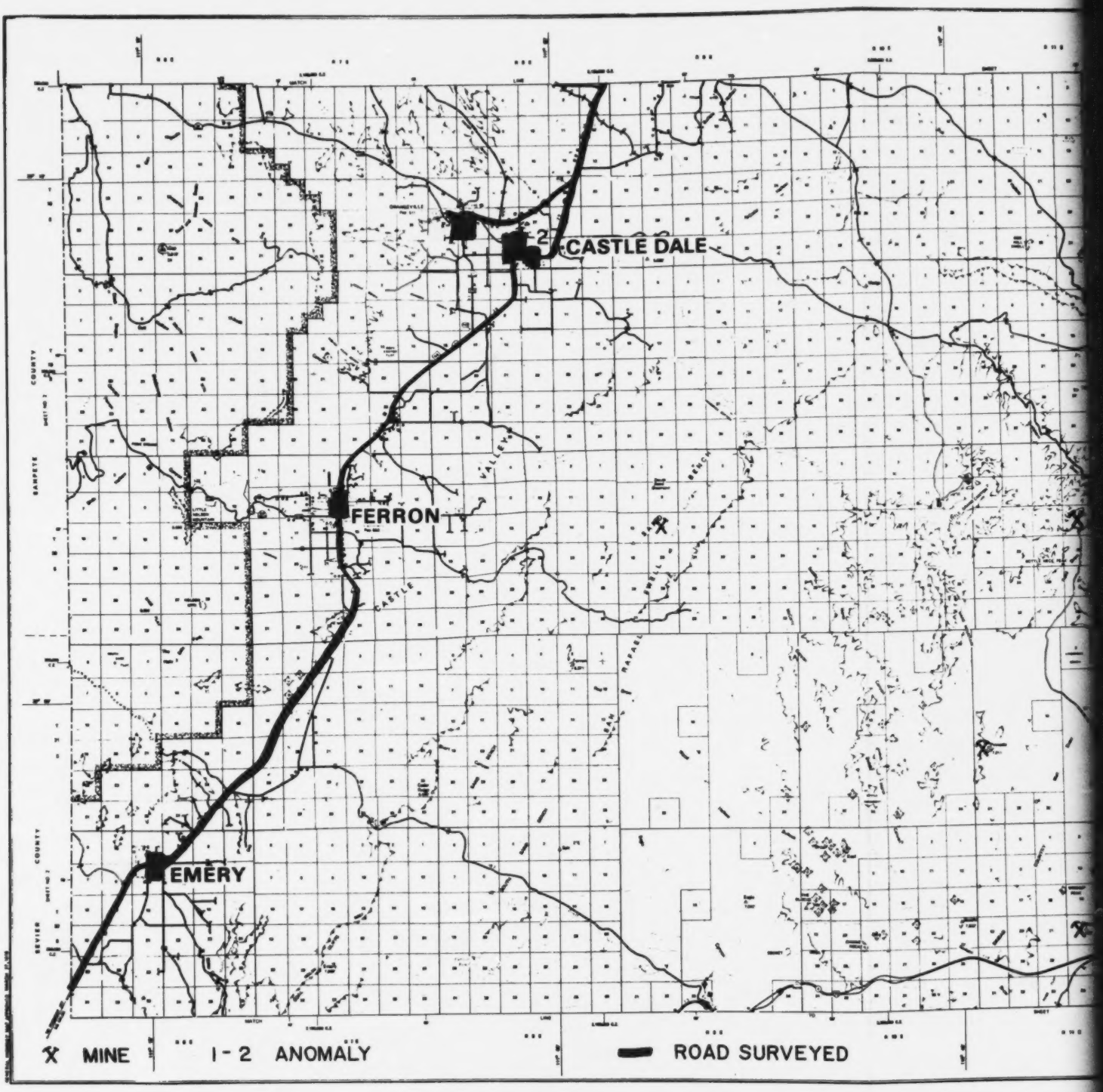

Figure B1. Emery County, Map No. 121, Chart No. 94

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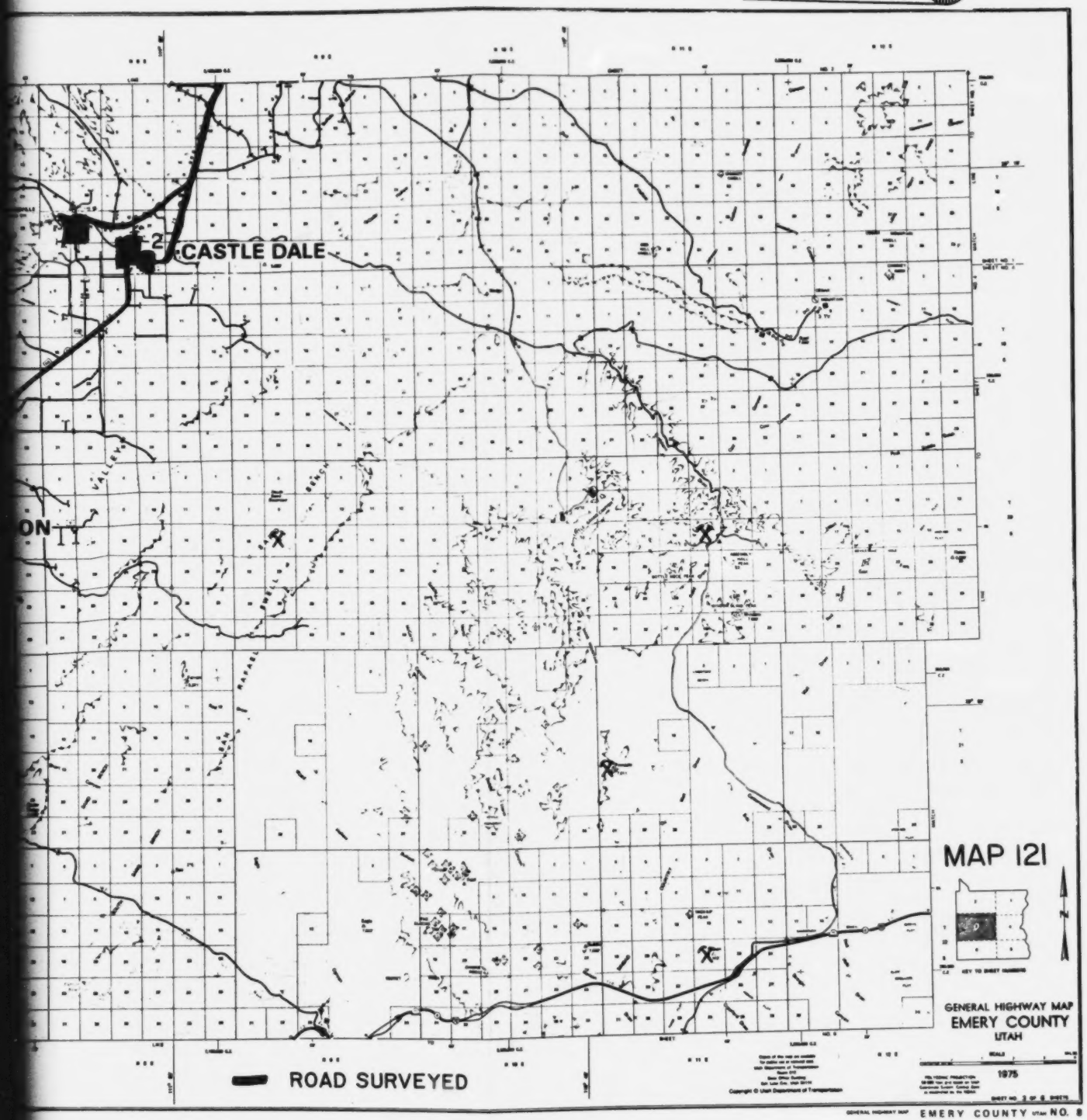

Figure B1. Emery County, Map No. 121, Chart No. 94

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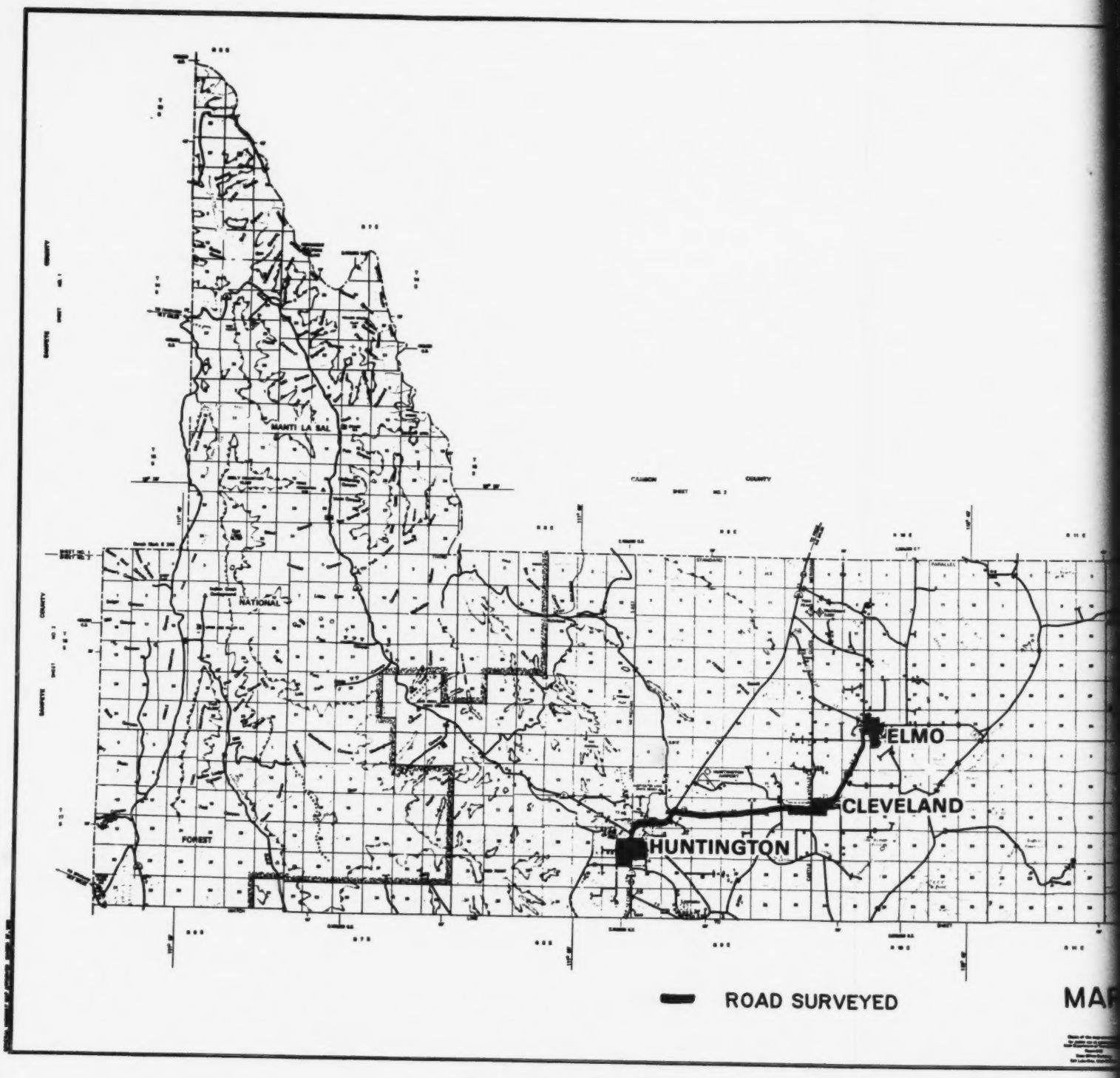

Figure B2. Emery County, Map No. 122, Chart No. 94

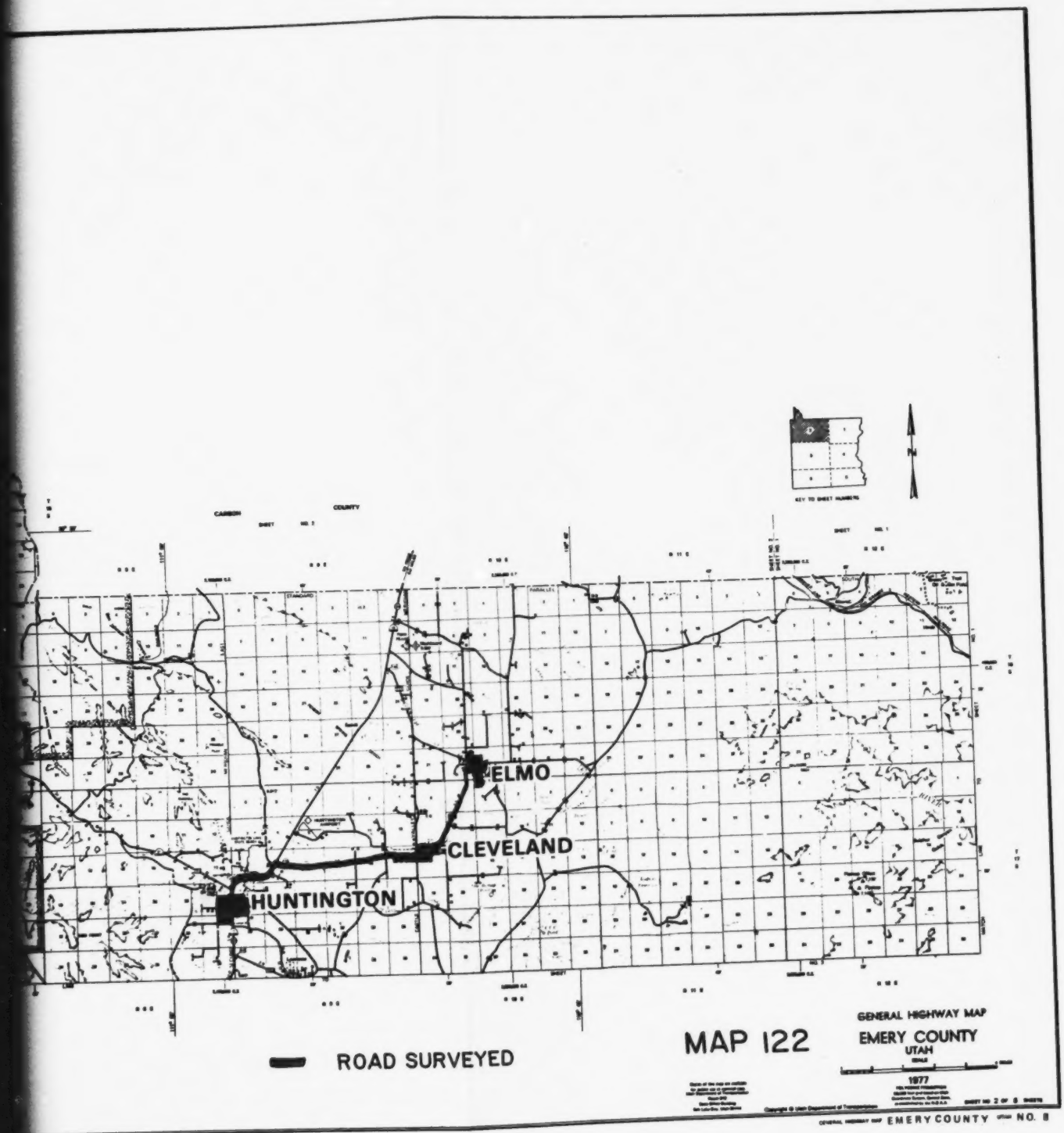

Figure B2. Emery County, Map No. 122, Chart No. 94

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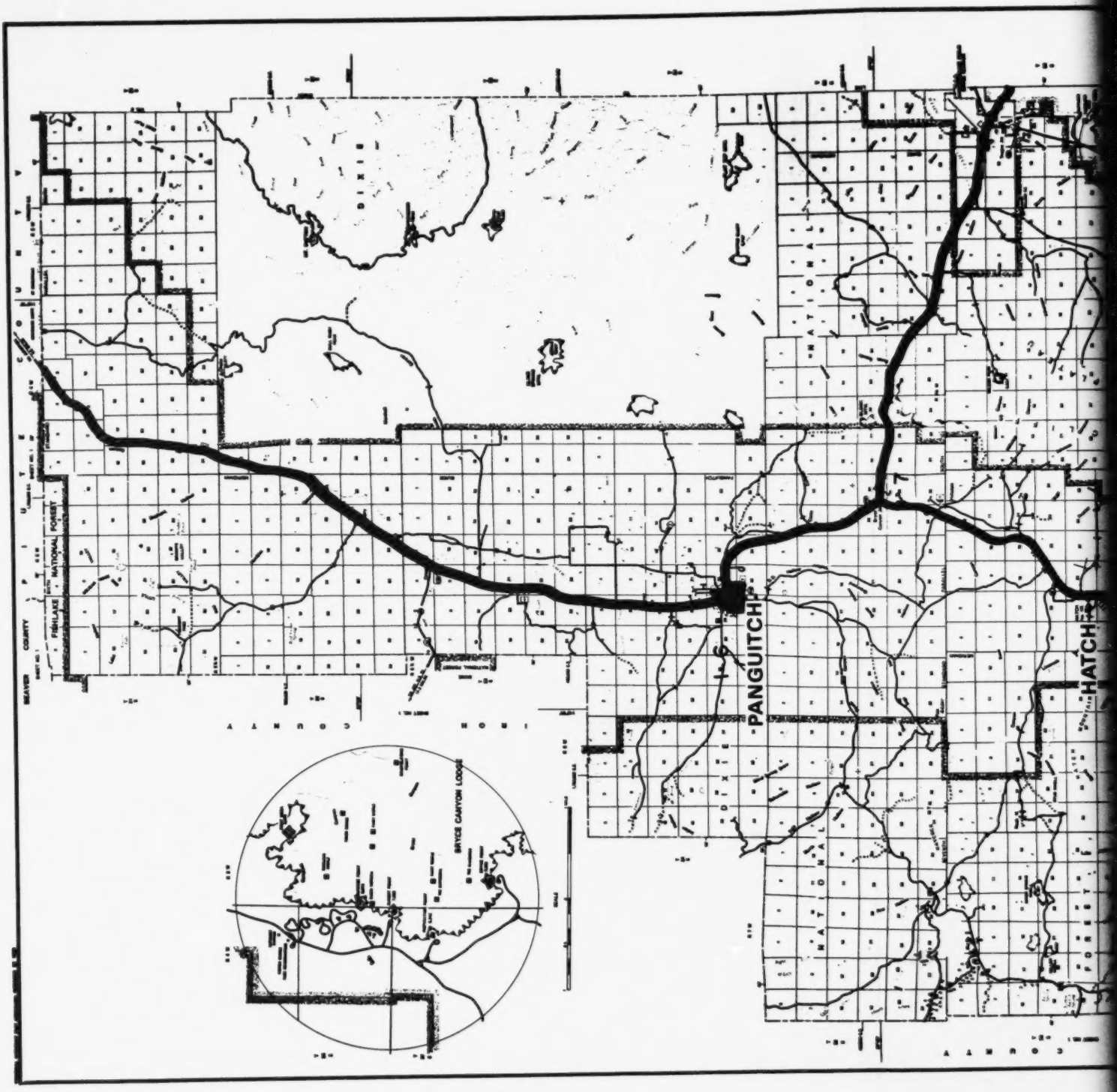

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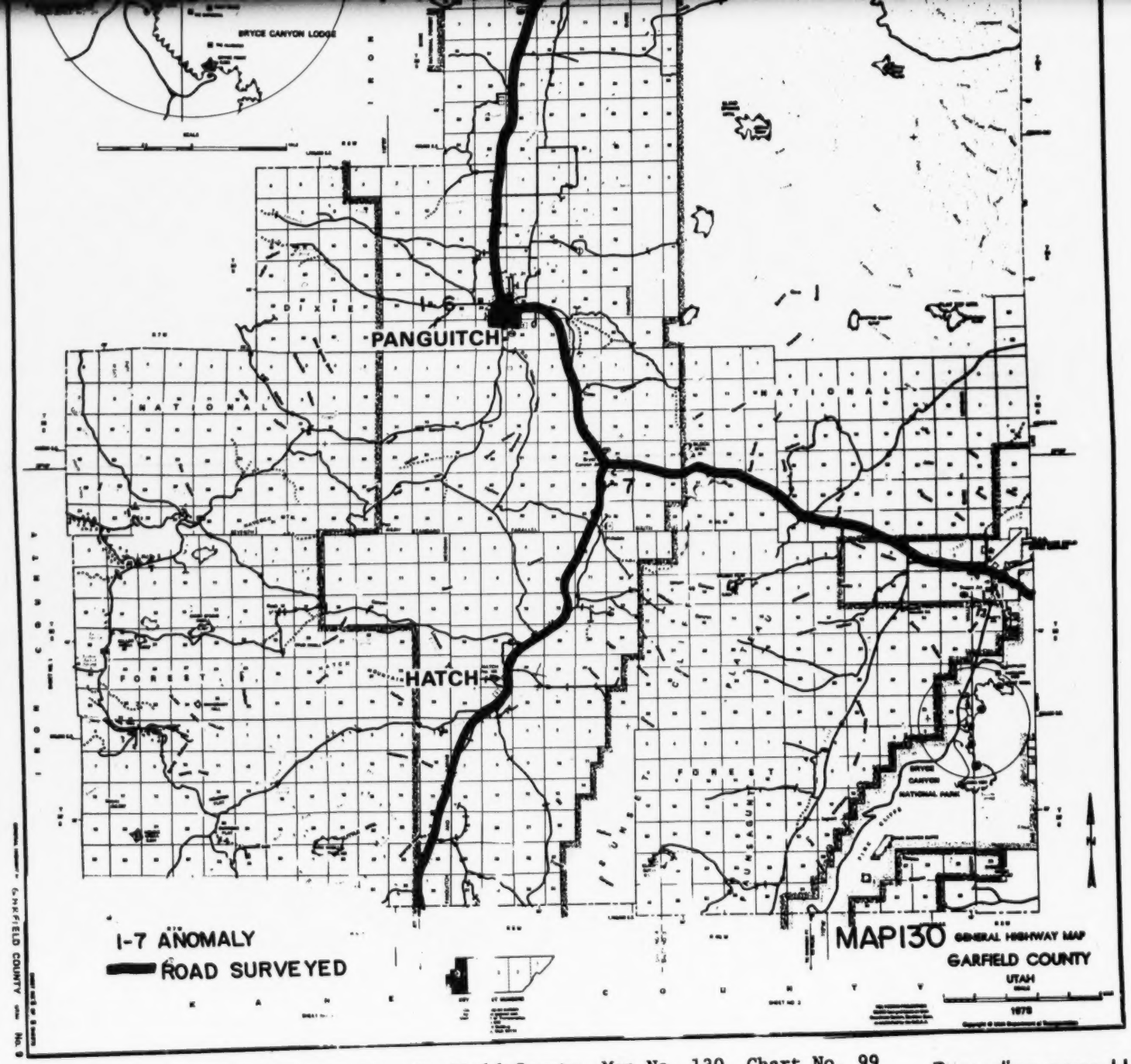

Figure B3. Garfield County, Map No. 130, Chart No. 99

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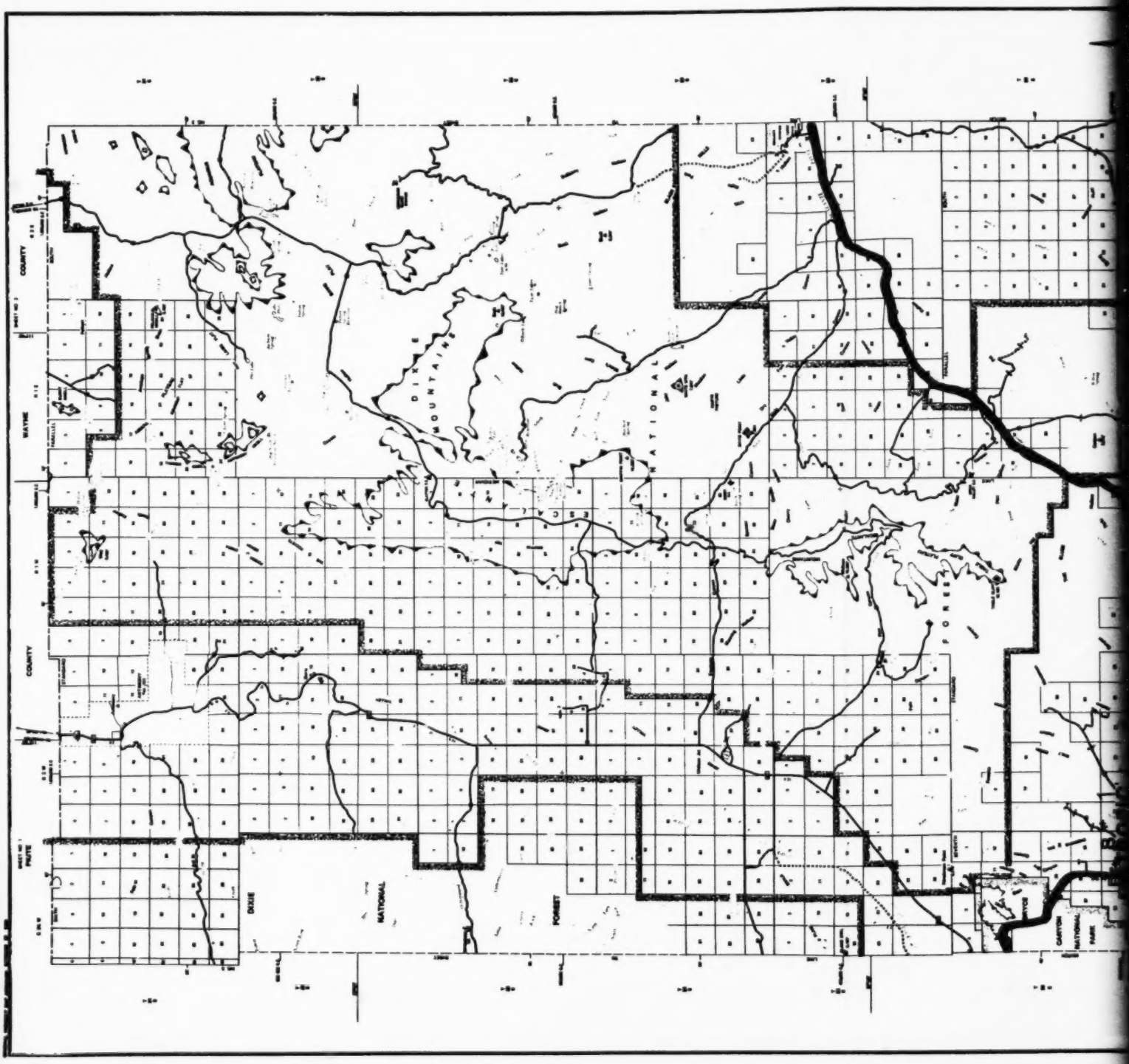
COUNTY
WAYNE
COUNTY
PIUTE
DIXIE
NATIONAL
FOREST
DIXIE
MOUNTAINS
NATIONAL
FOREST
CANYON
NATIONAL
PARK

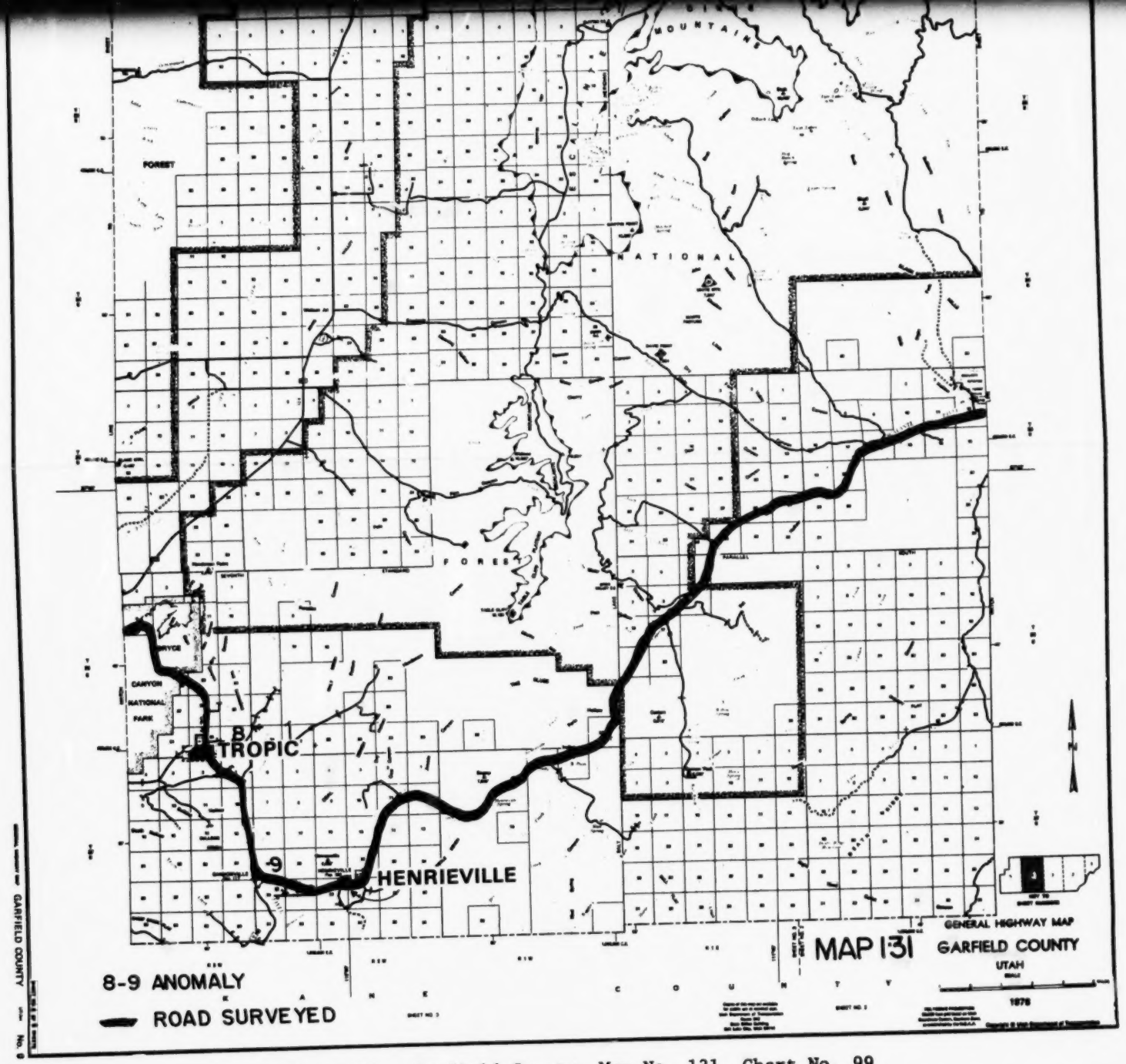

Figure B4. Garfield County, Map No. 131, Chart No. 99

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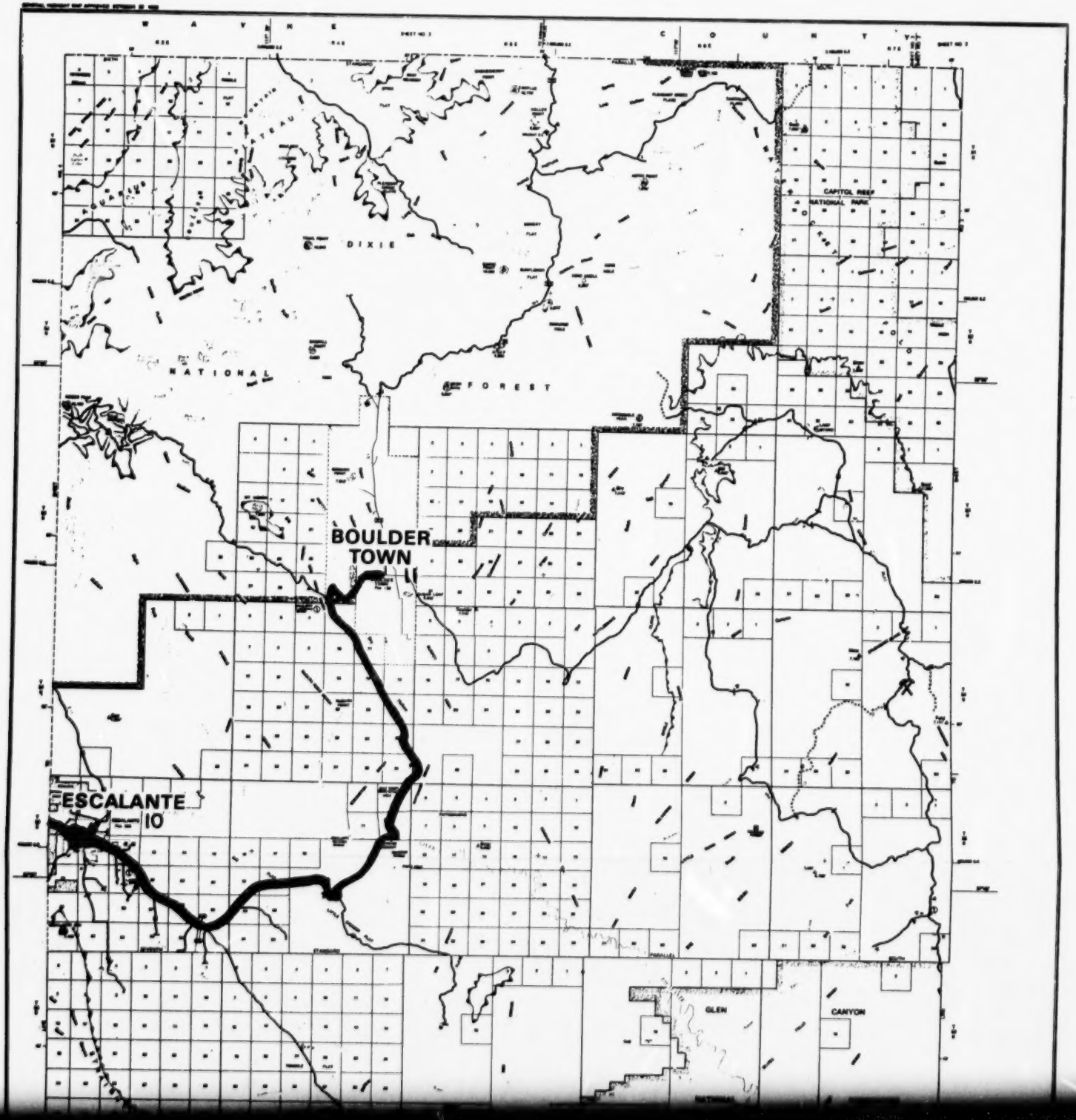
W A Y N E
C O U N T Y
DIXIE
NATIONAL
FOREST
CAPITOL REEF
NATIONAL PARK
BOULDER
TOWN
11
ESCALANTE
10
GLEN
CANYON

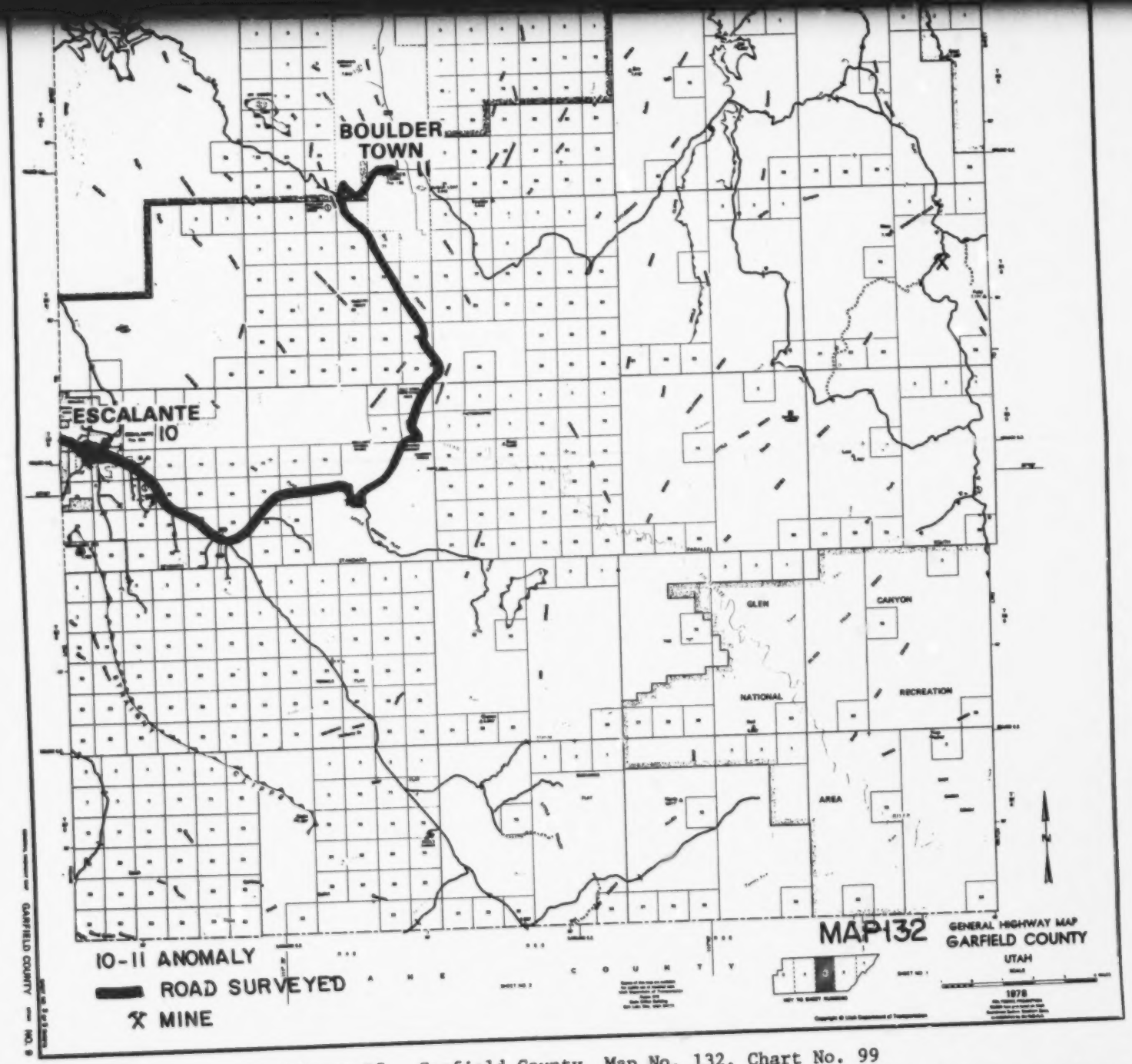

Figure B5. Garfield County, Map No. 132, Chart No. 99

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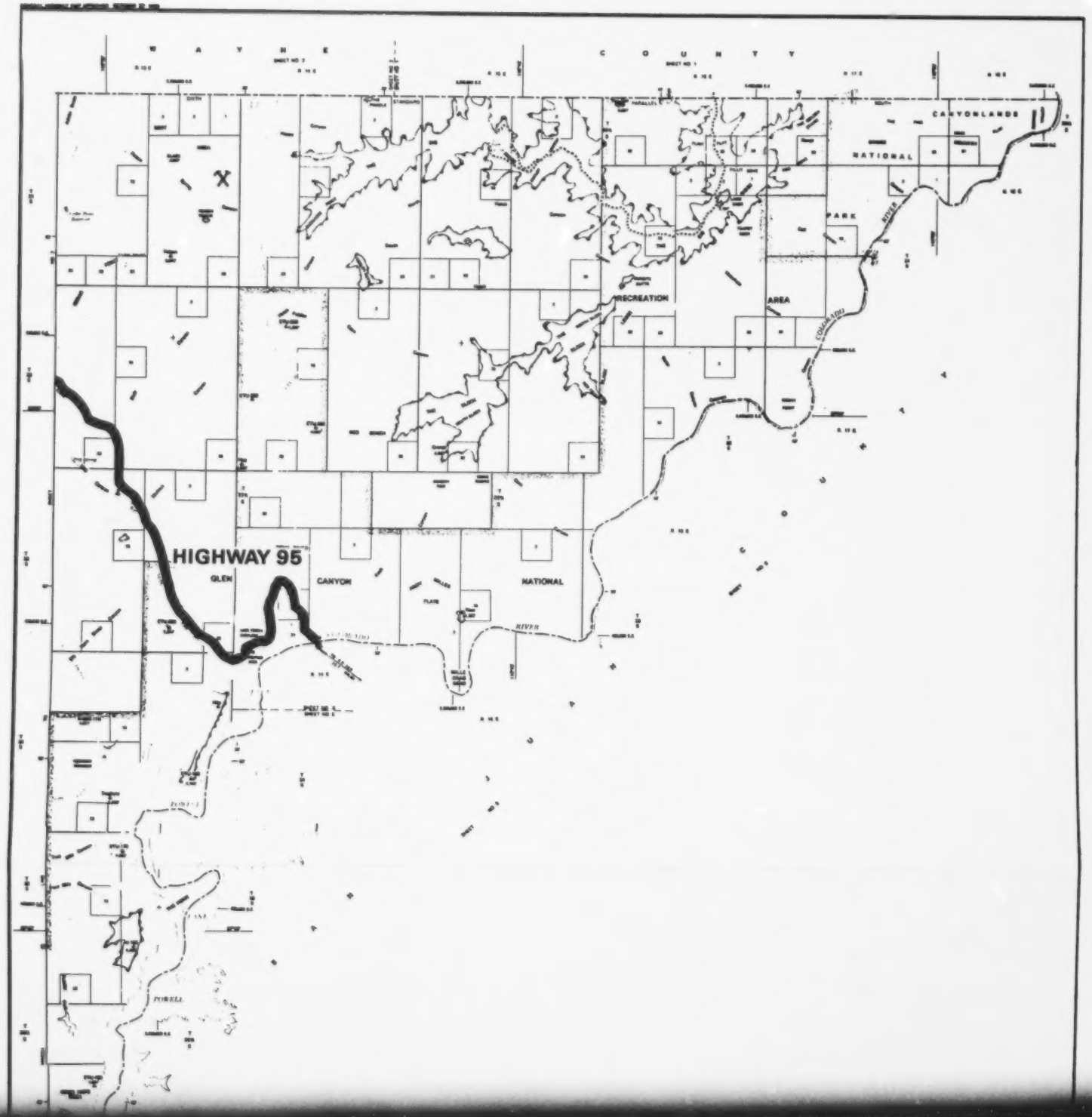
W A Y N E
C O U N T Y
CANYONLANDS
NATIONAL
PARK
RECREATION
AREA
HIGHWAY 95
GLEN
CANYON
NATIONAL

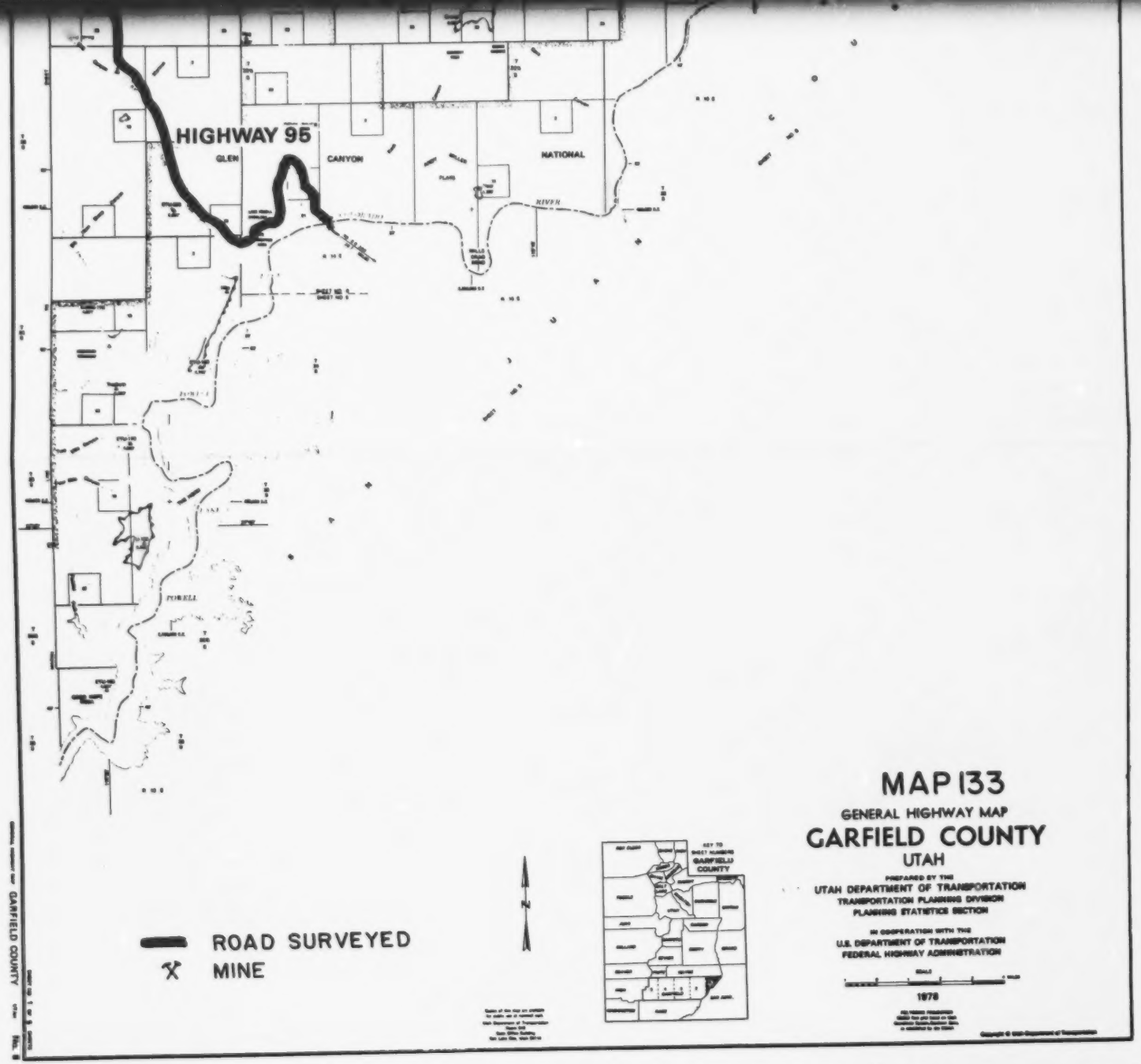

Figure B6. Garfield County, Map No. 133, Chart No. 99

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MINE

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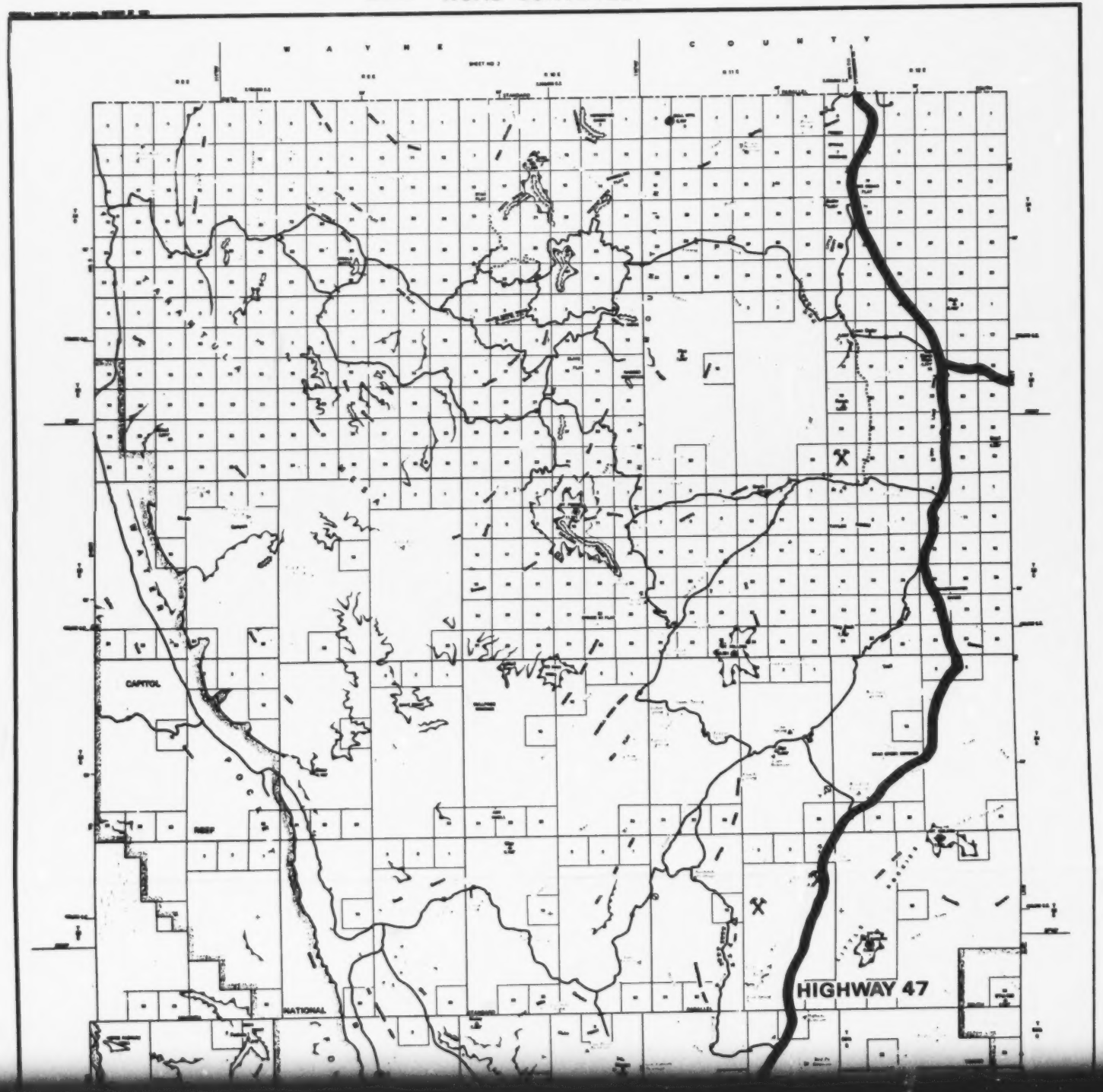

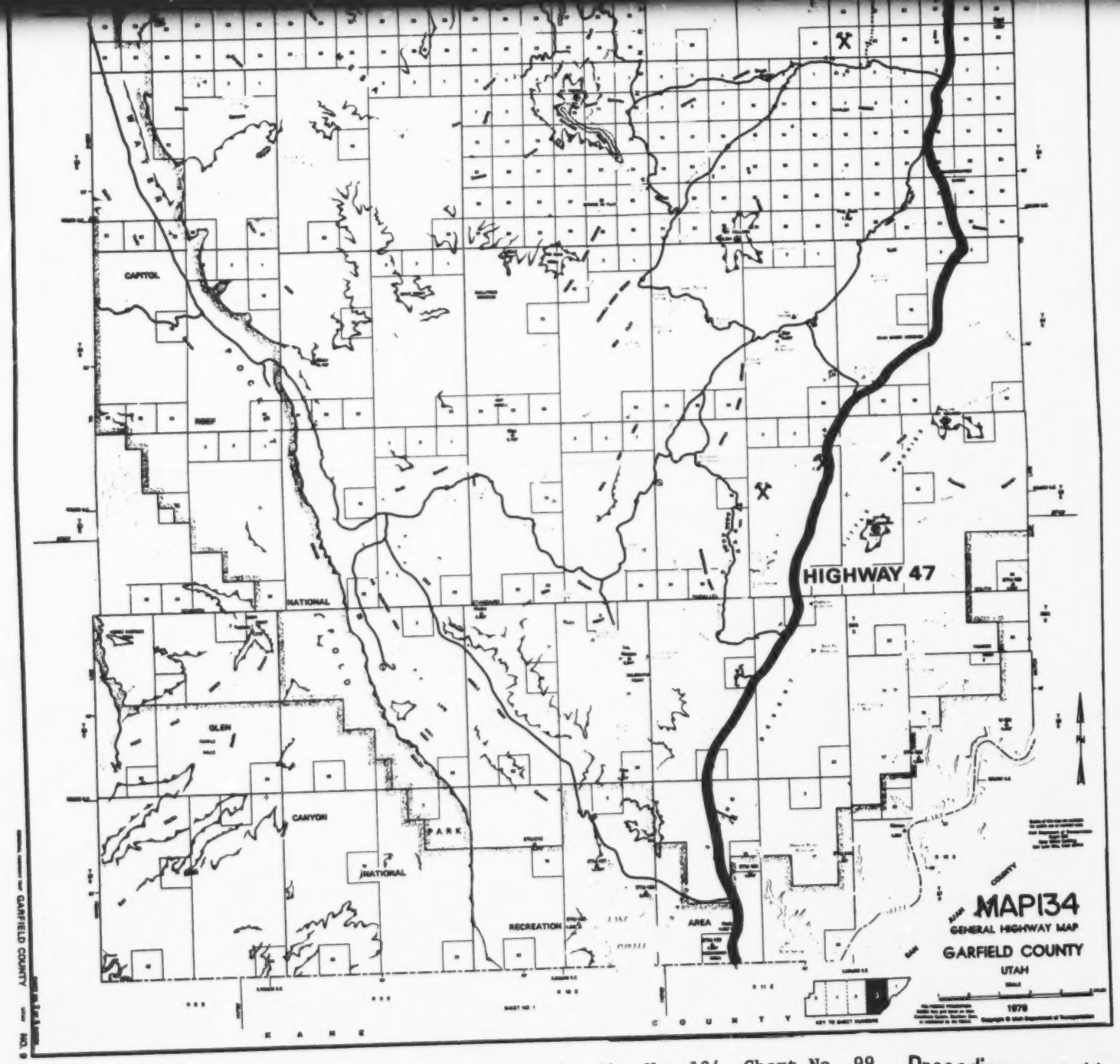

Figure B7. Garfield County, Map No. 134, Chart No. 99

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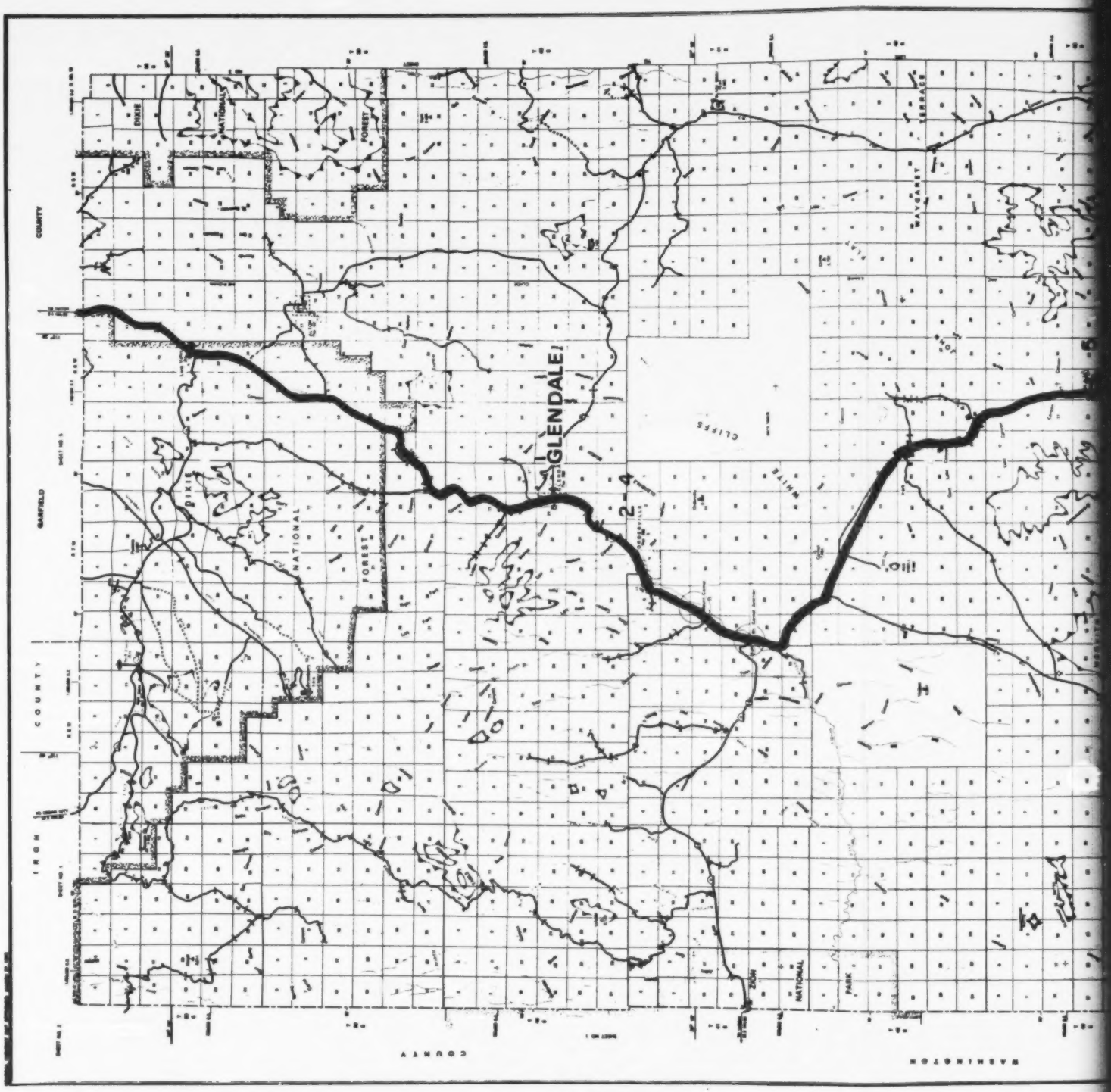
GLENDALE
2-4
DIXIE
NATIONAL
FOREST
WHITE
CLIFFS
WAYGARET
TERRACE
ZION
NATIONAL
PARK
IRON
COUNTY
GARFIELD
COUNTY
WASHINGTON
COUNTY

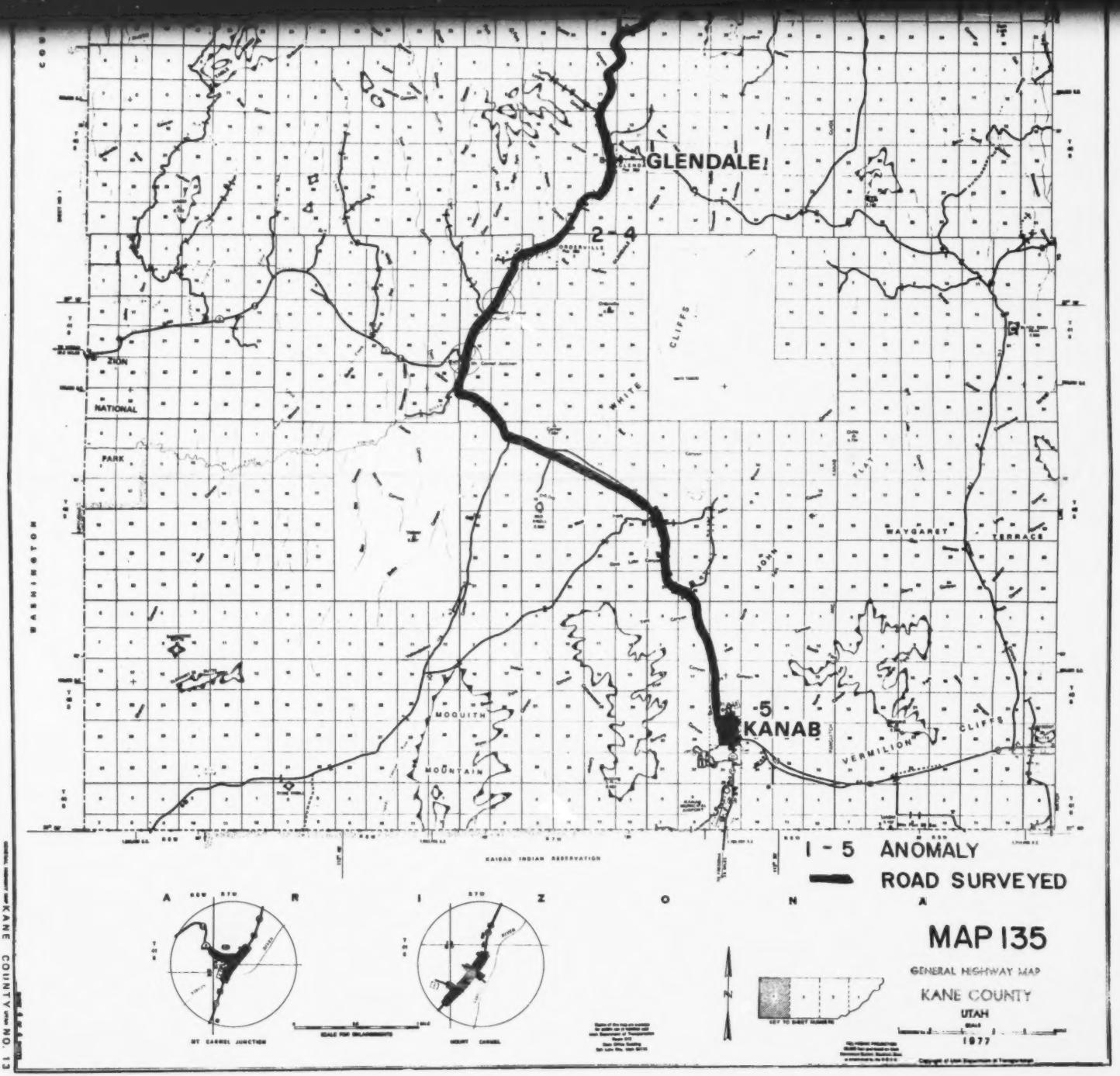

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Figure B8. Kane County, Map No. 135, Chart No. 100

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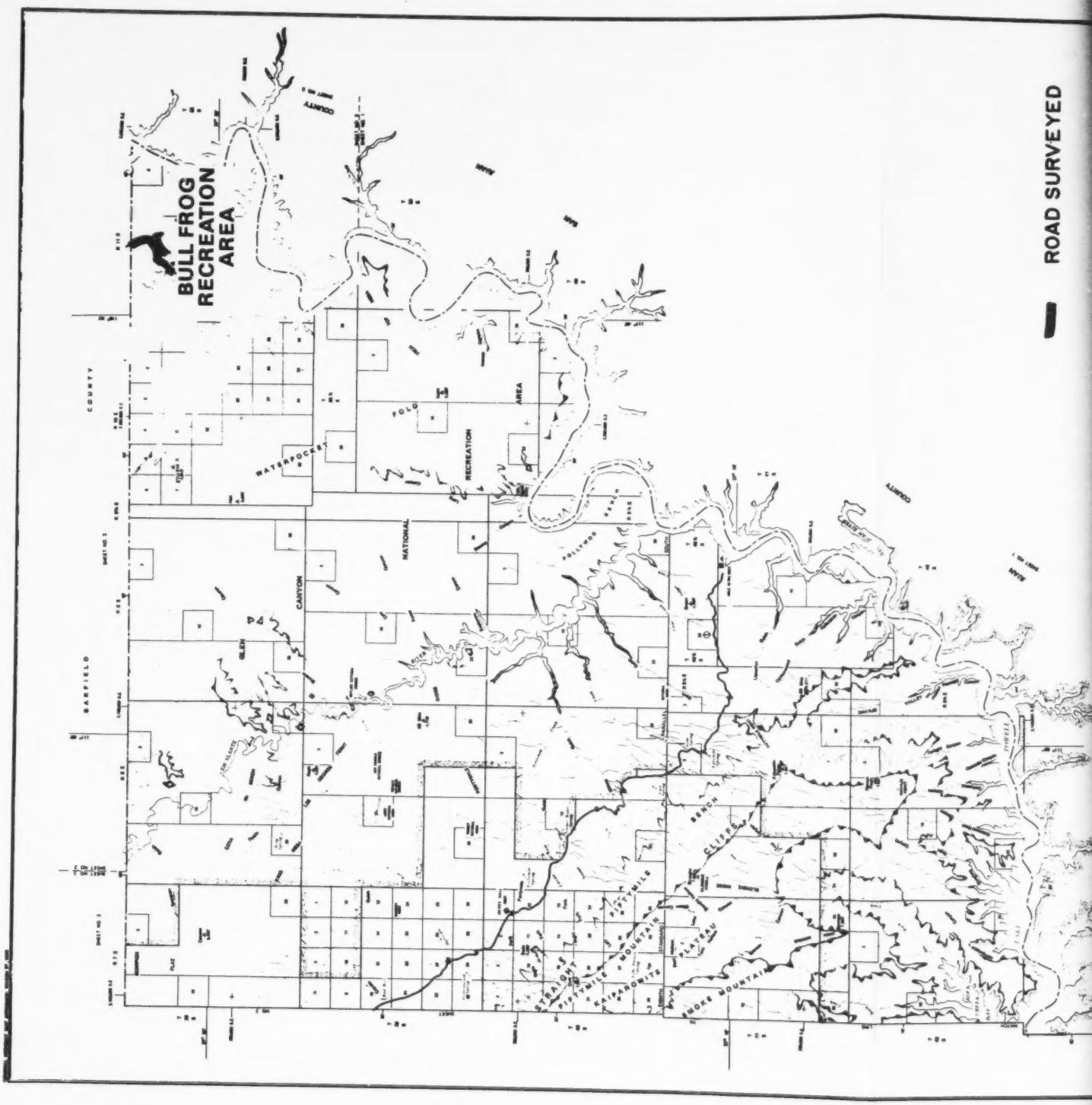
BULL FROG
RECREATION
AREA
ROAD SURVEYED
WATERPOCKET
FOLD
RECREATION
AREA
NATIONAL
CANYON
GLEN
BARFIELD
COUNTY
COUNTY
FIFTYMILE
BENCH
CLIFFS
STRAIGHT
FIFTYMILE
MOUNTAIN
KAIPAROWITS
PLATEAU
SMOKE MOUNTAIN

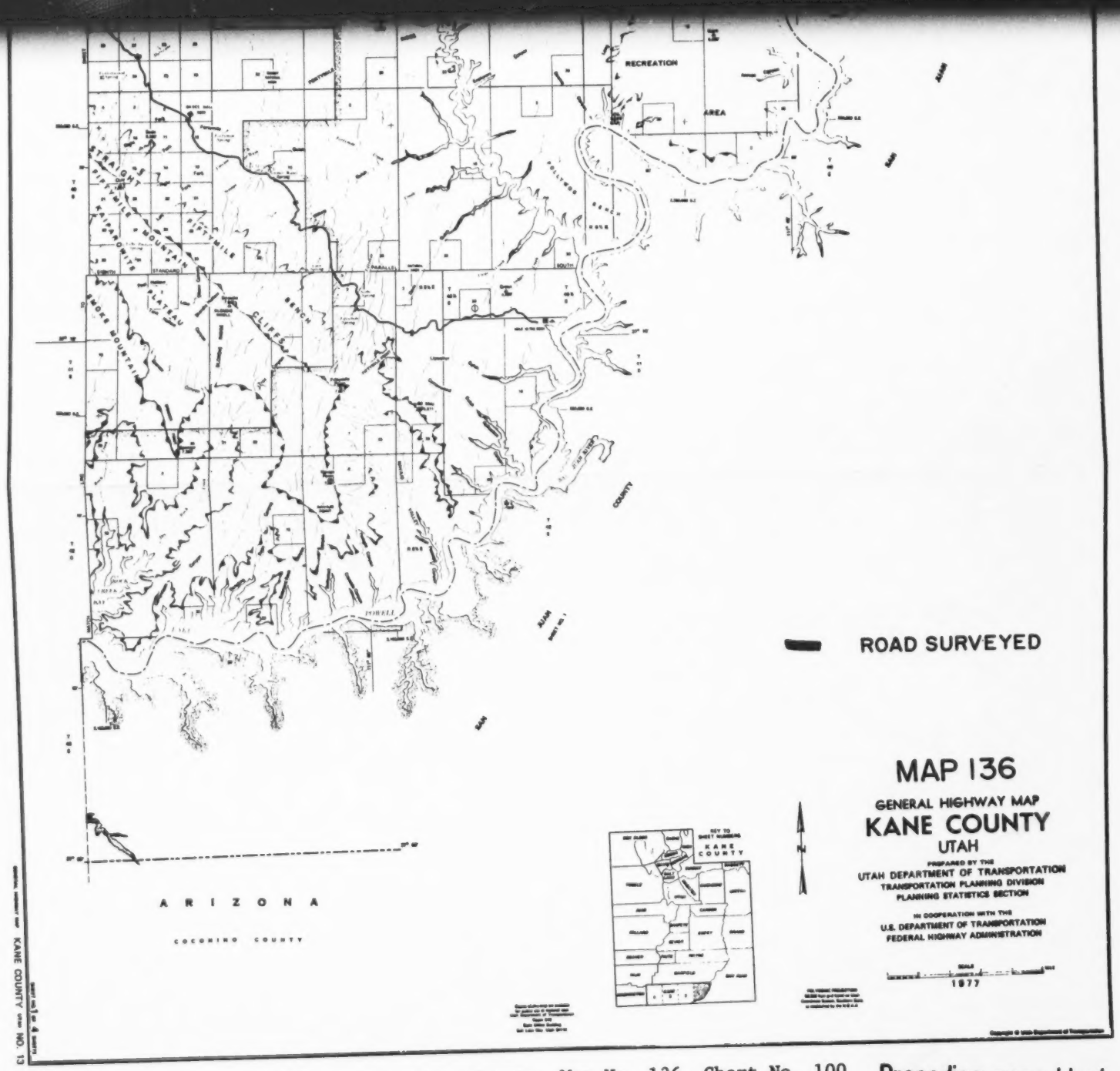

Figure B9. Kane County, Map No. 136, Chart No. 100

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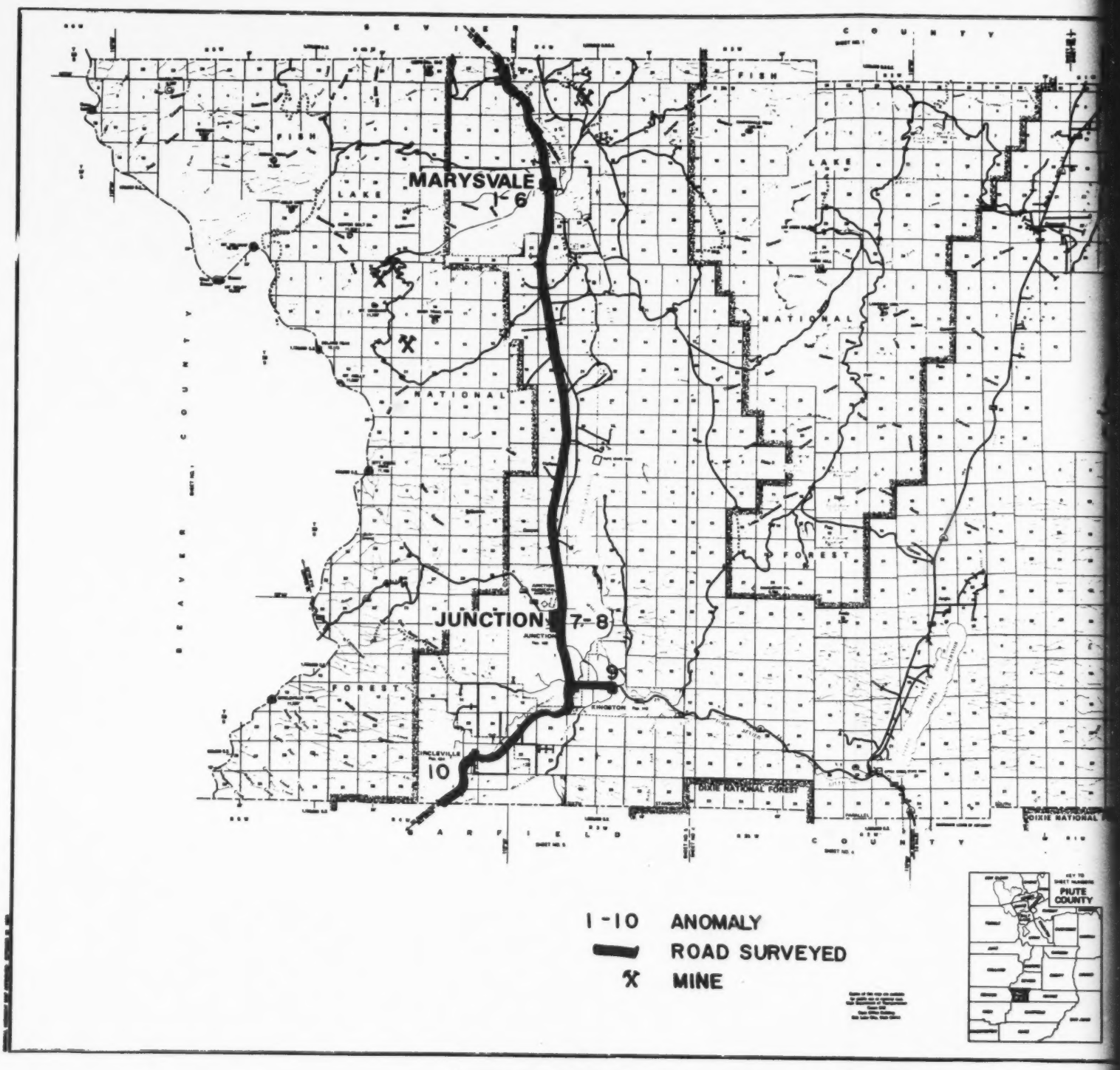

Figure B10. Piute County, Map No. 127, Chart No. 97

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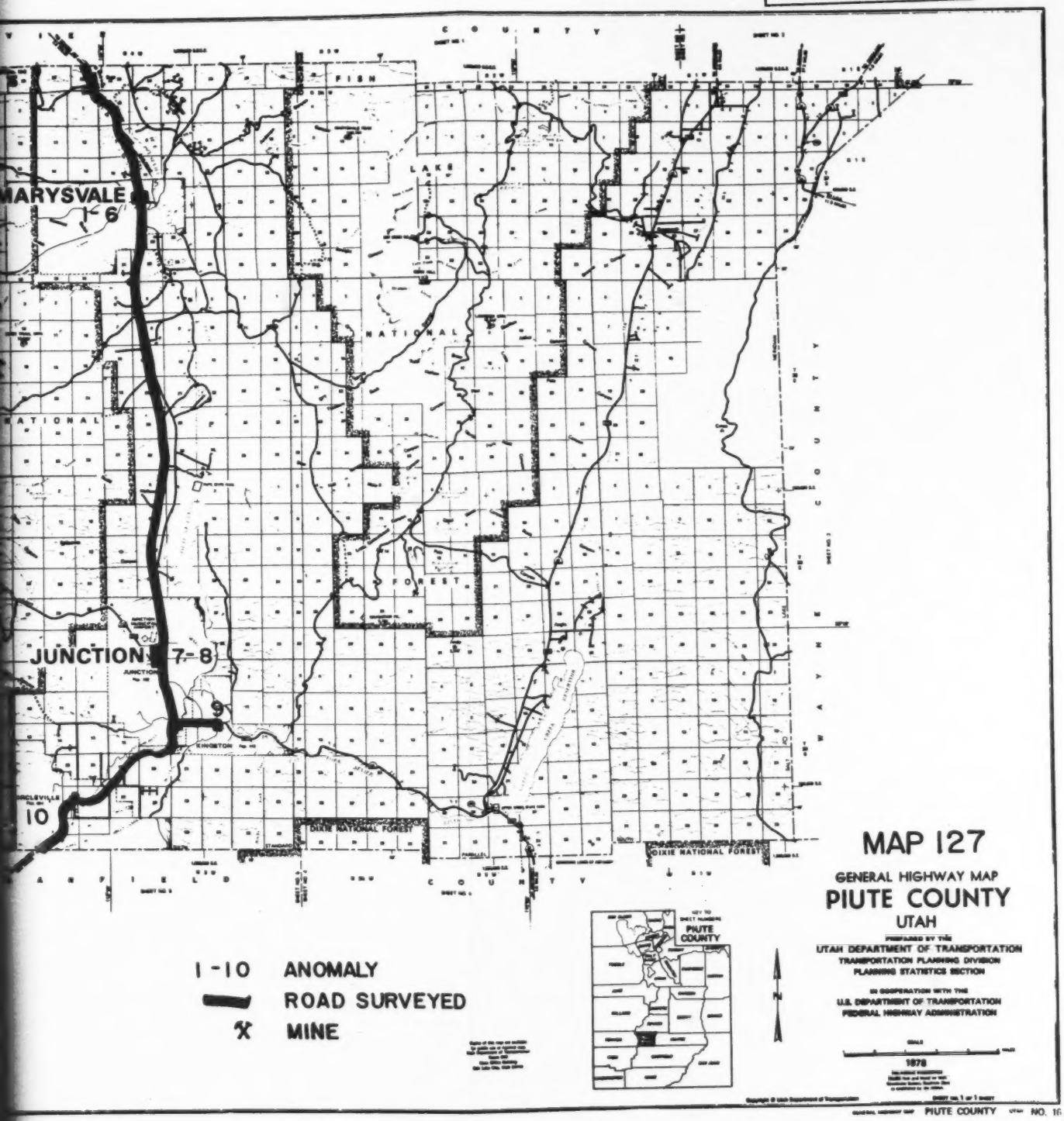

Figure B10. Piute County, Map No. 127, Chart No. 97

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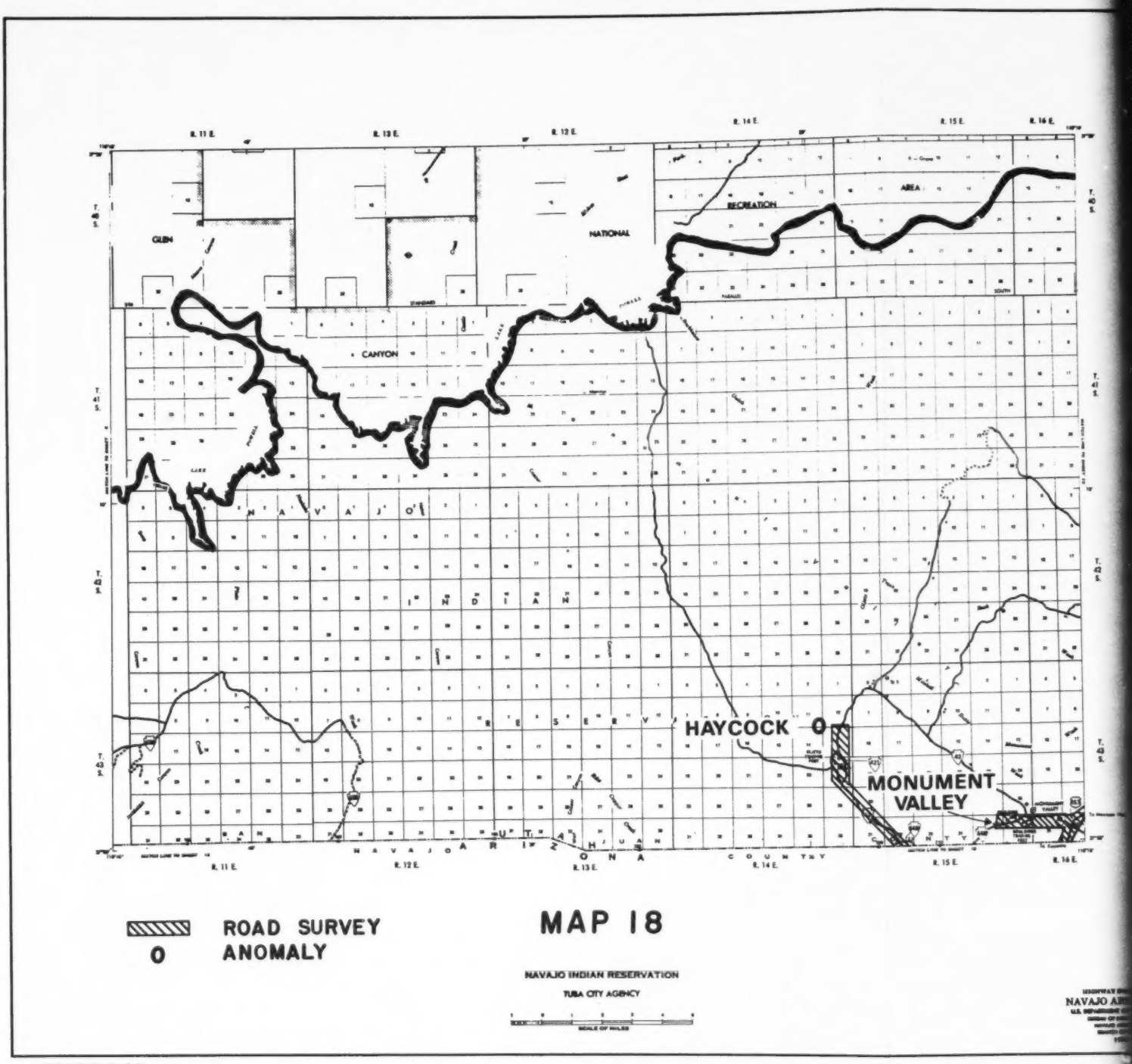

Figure B11. San Juan County, Map No. 18, Chart No. 9

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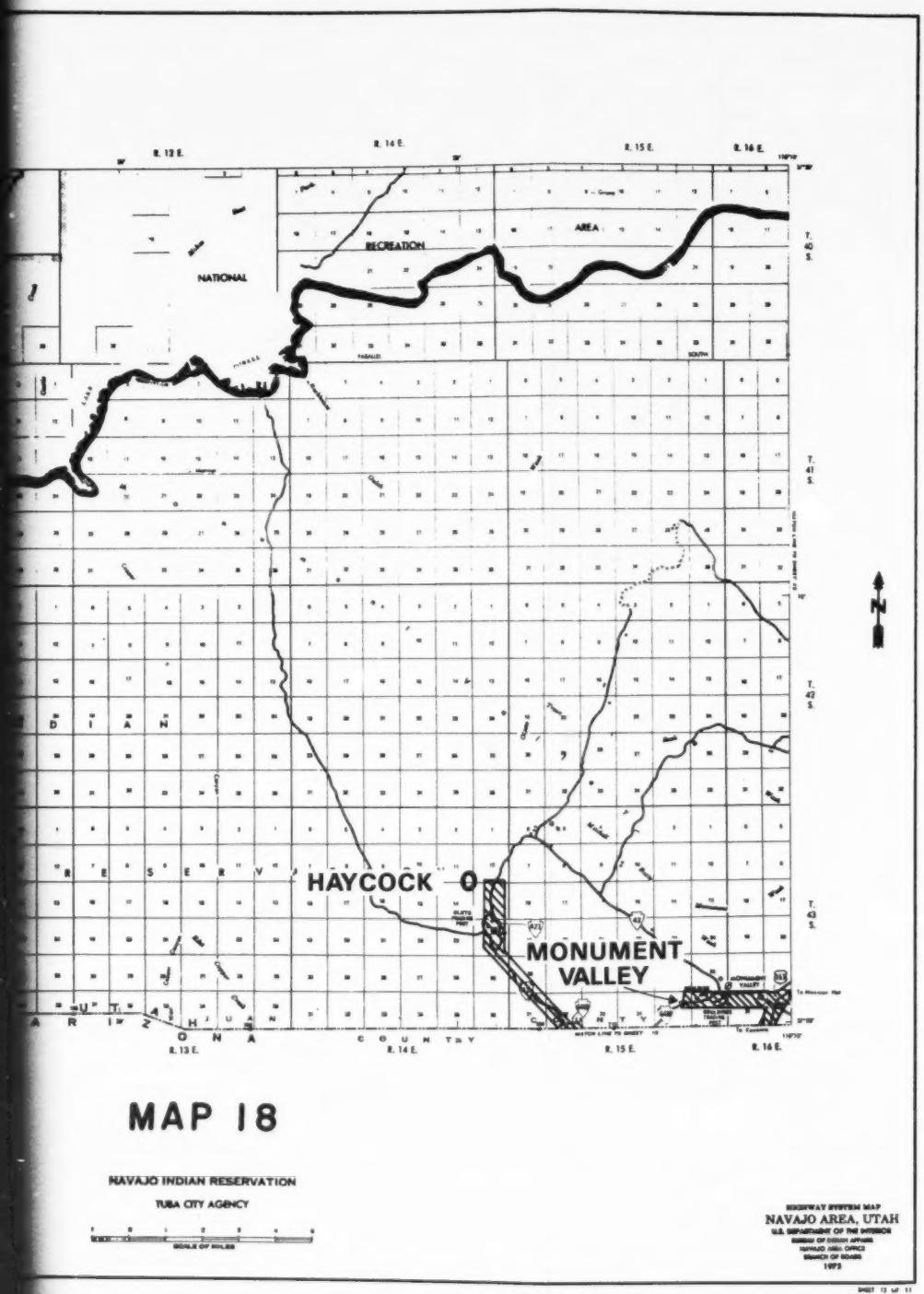

MAP 18

NAVAJO INDIAN RESERVATION

TUBA CITY AGENCY

SCALE OF MILES

HIGHWAY SYSTEM MAP
NAVAJO AREA, UTAH
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS
NAVAJO AREA OFFICE
BRANCH OF ROADS
1973

SHEET 12 of 11

San Juan County, Map No. 18, Chart No. 9

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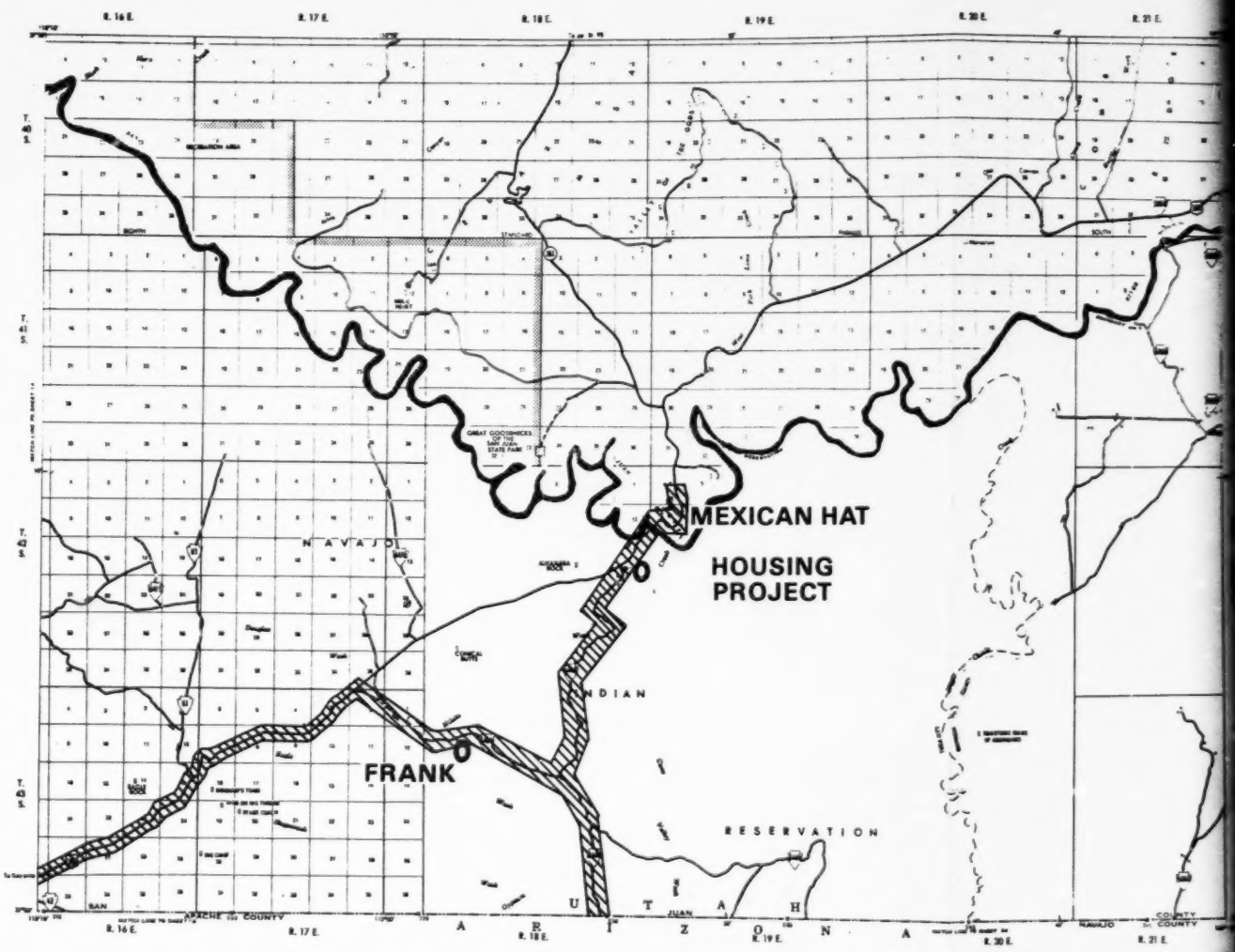

Figure B12. San Juan County, Map No. 19, Chart No. 9

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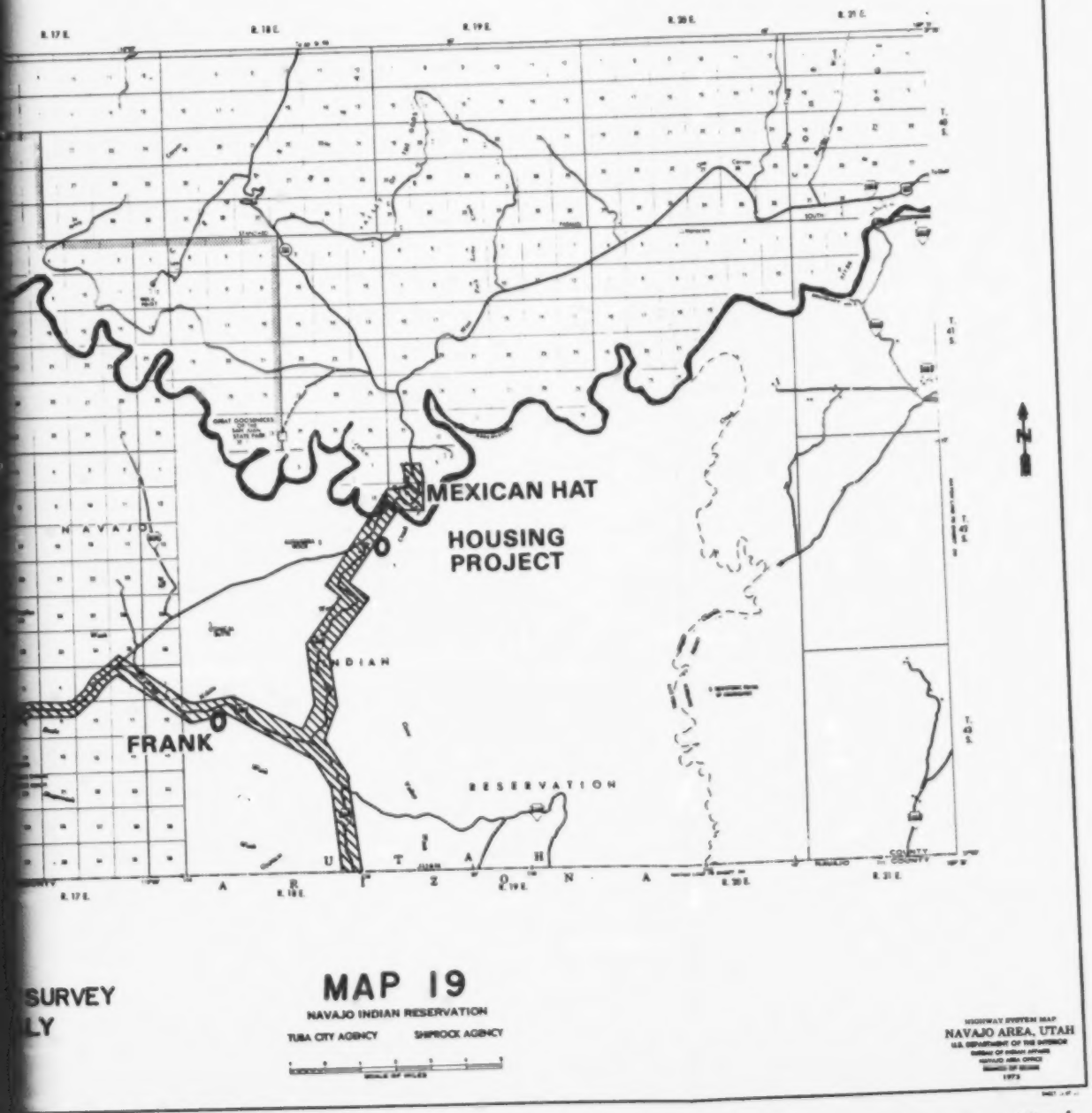

Figure B12. San Juan County, Map No. 19, Chart No. 9

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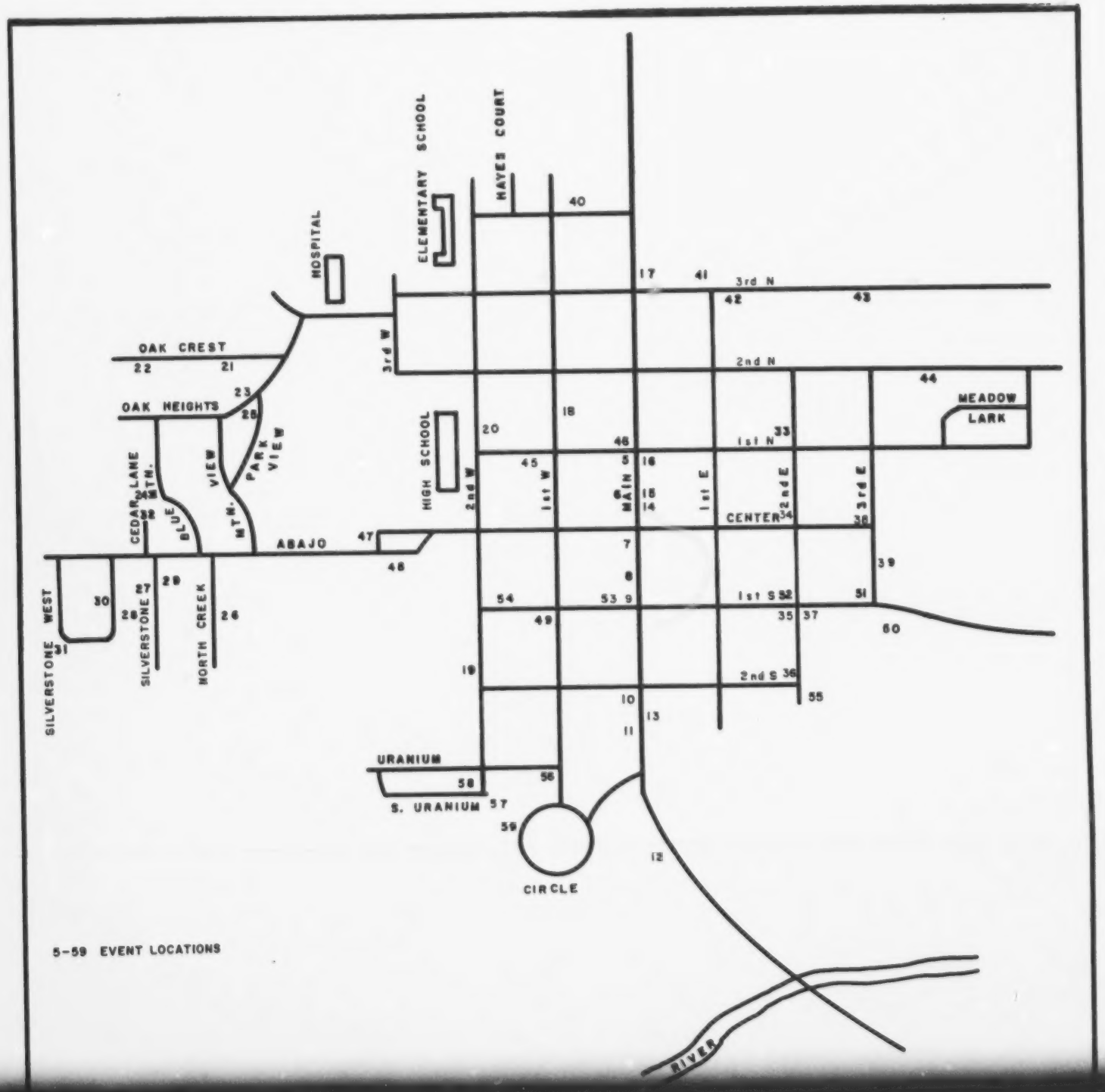
HOSPITAL
ELEMENTARY SCHOOL
HAYES COURT
3rd N
2nd N
1st N
1st S
2nd S
3rd W
2nd W
1st W
MAIN
1st E
2nd E
3rd E
CENTER
HIGH SCHOOL
OAK CREST
OAK HEIGHTS
CEDAR LANE
BLUE MTN.
VIEW
MTN.
PARK VIEW
ABAJO
SILVERSTONE WEST
SILVERSTONE
NORTH CREEK
MEADOW LARK
URANIUM
S. URANIUM
CIRCLE
RIVER
5-59 EVENT LOCATIONS

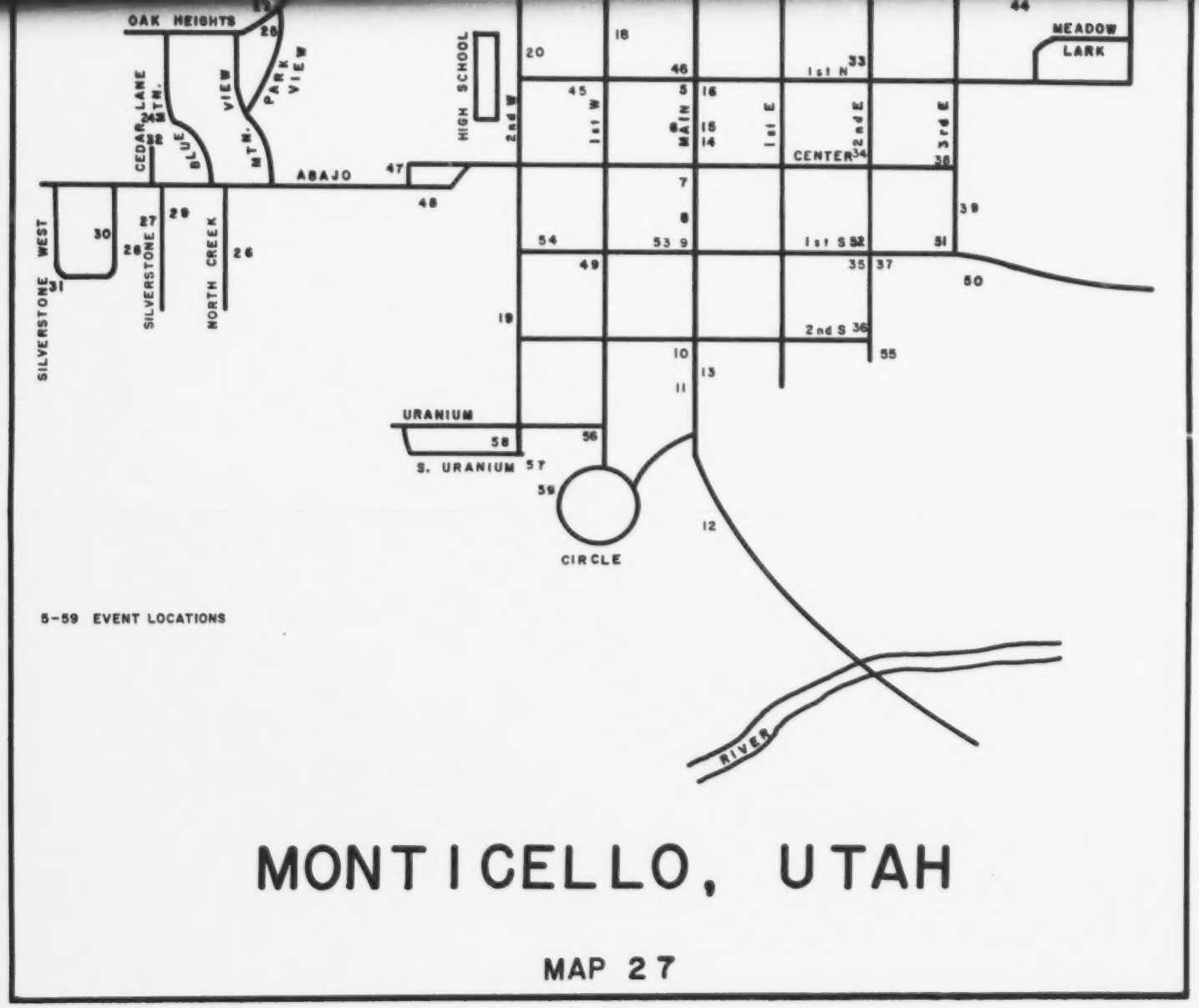

Figure B13. San Juan County, Map No. 27, Chart Nos. 23-24

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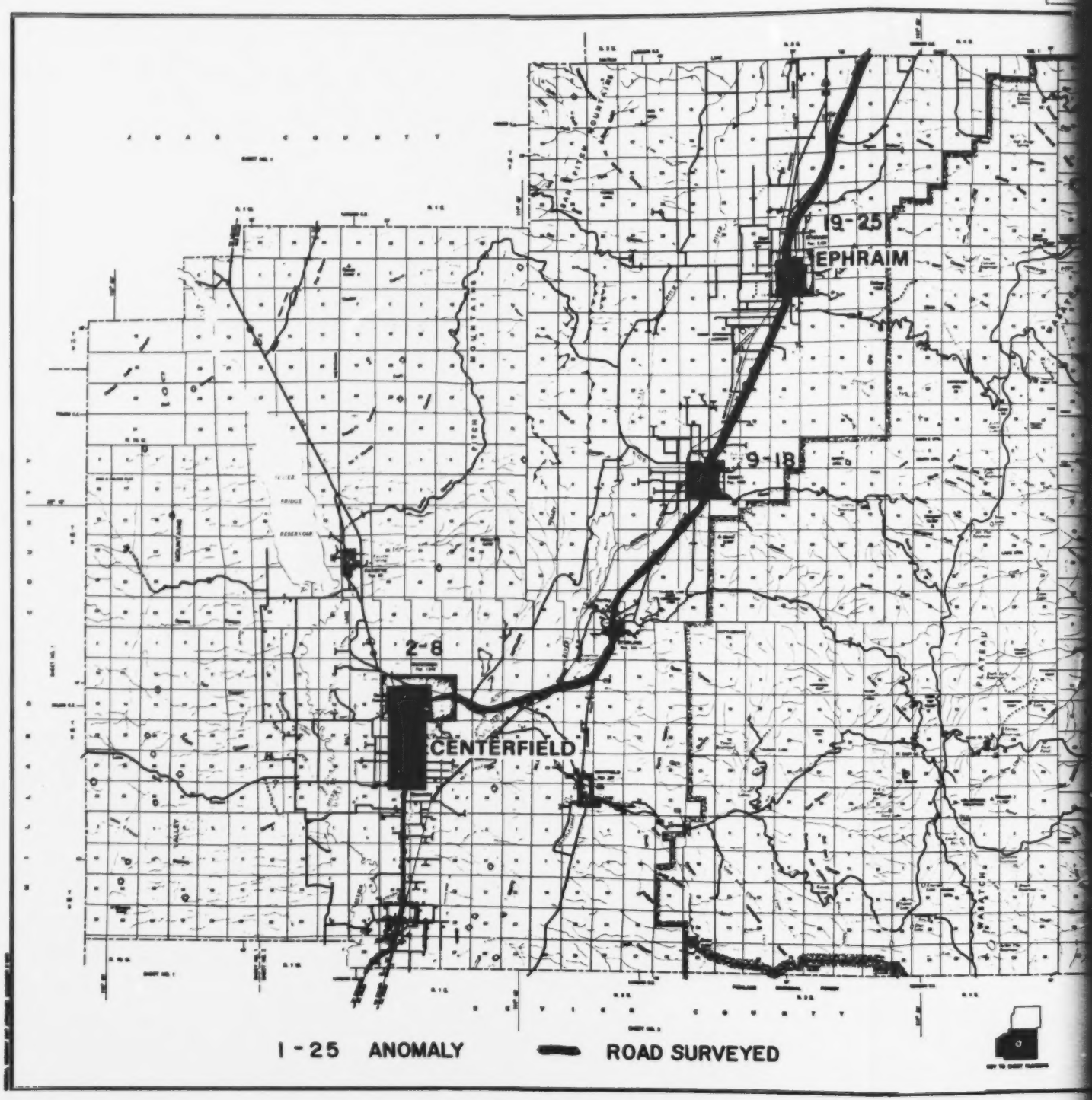

Figure B14. Sanpete County, Map No. 125, Chart No. 96

Reproduced from best available copy.

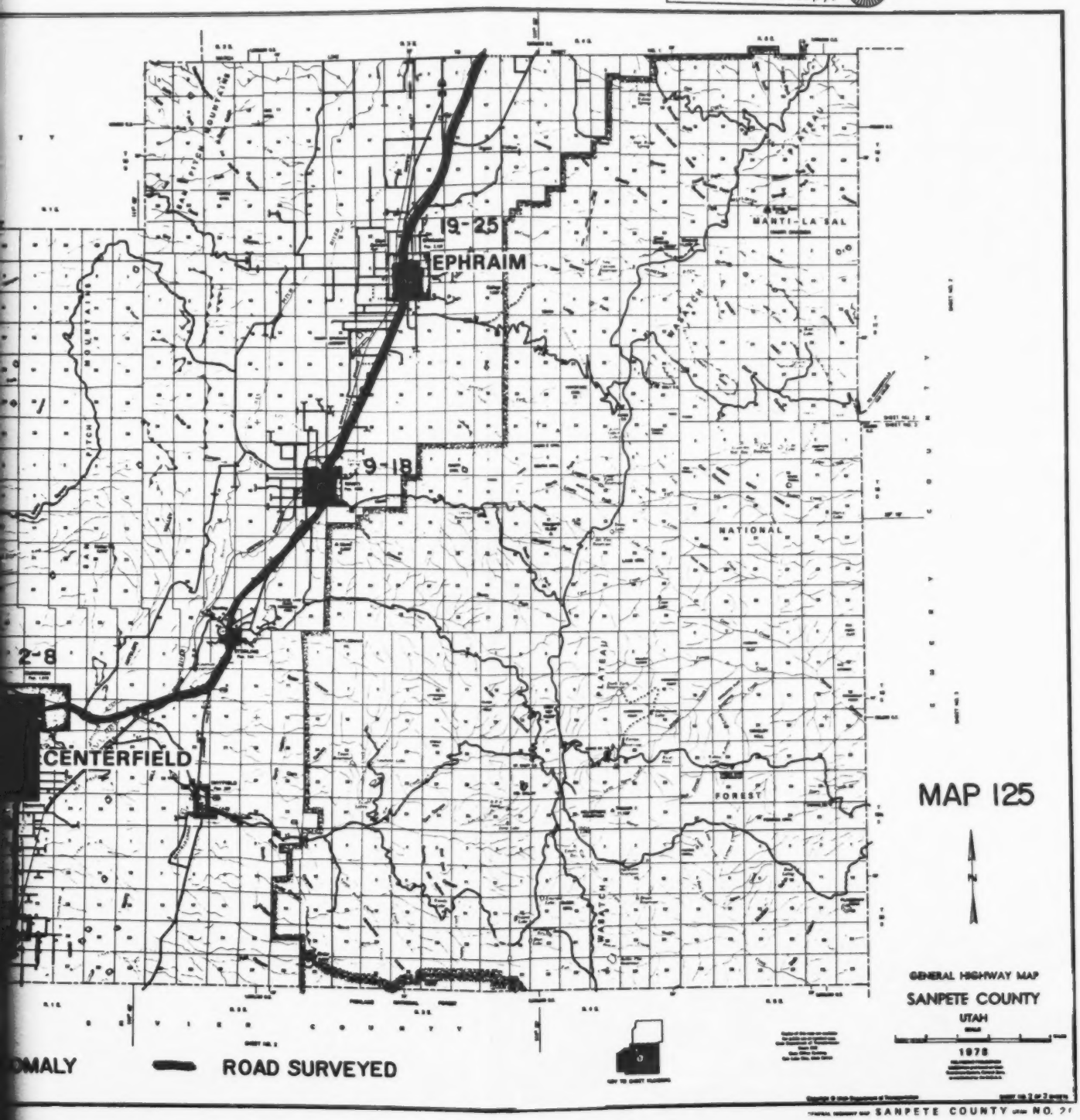

Figure B14. Sanpete County, Map No. 125, Chart No. 96

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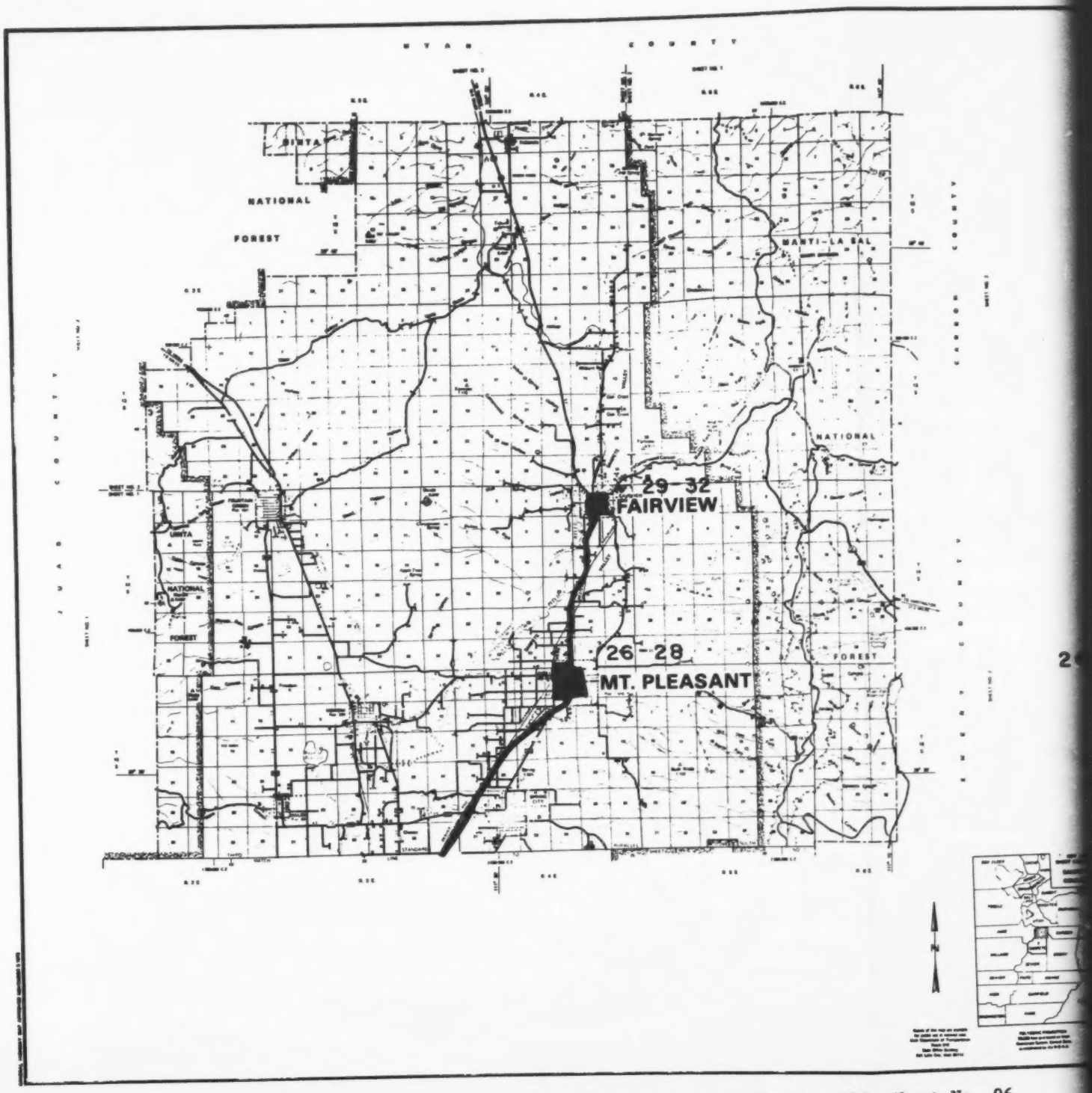

Figure B15. Sanpete County, Map No. 126, Chart No. 96

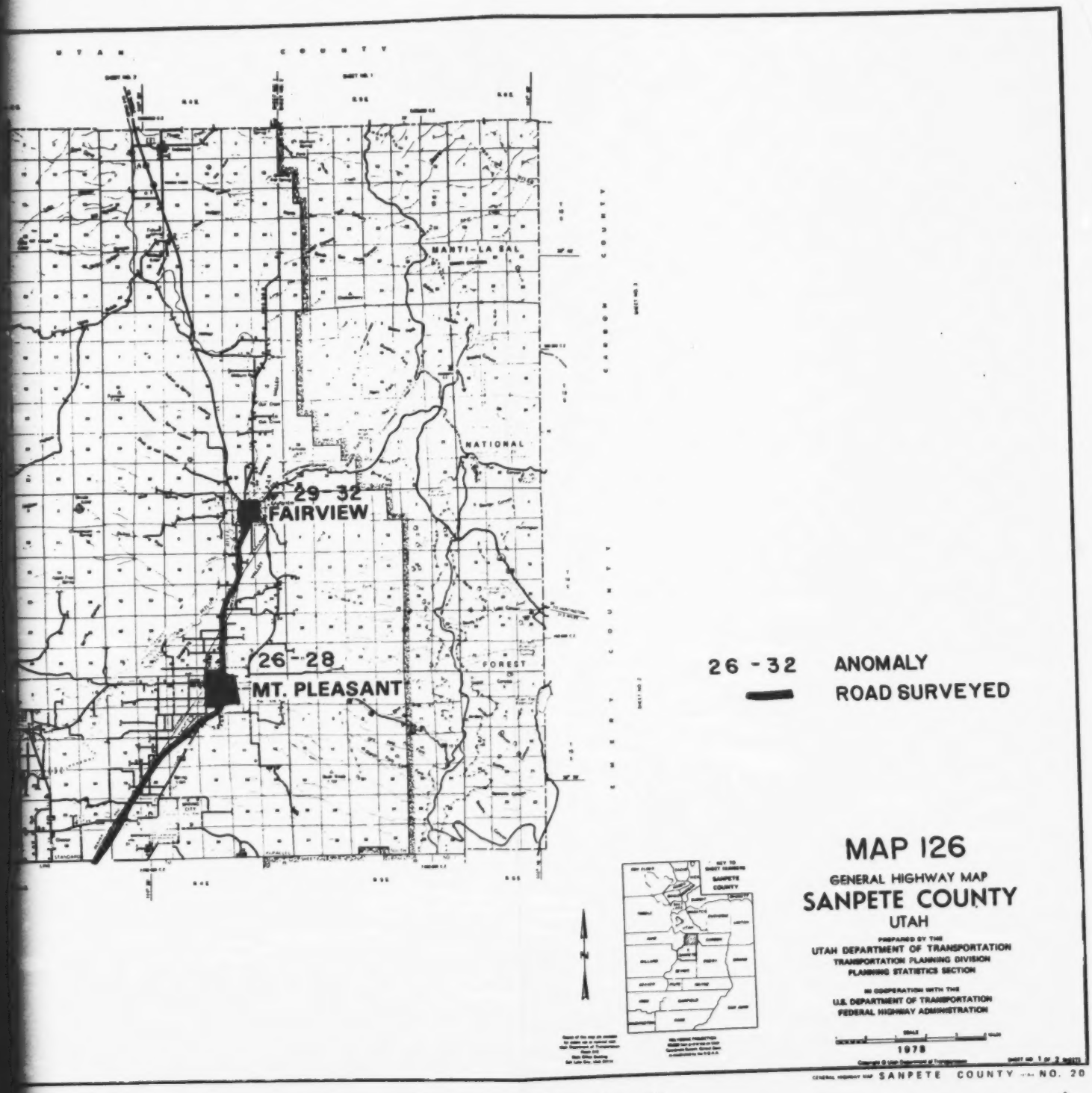

Figure B15. Sanpete County, Map No. 126, Chart No. 96

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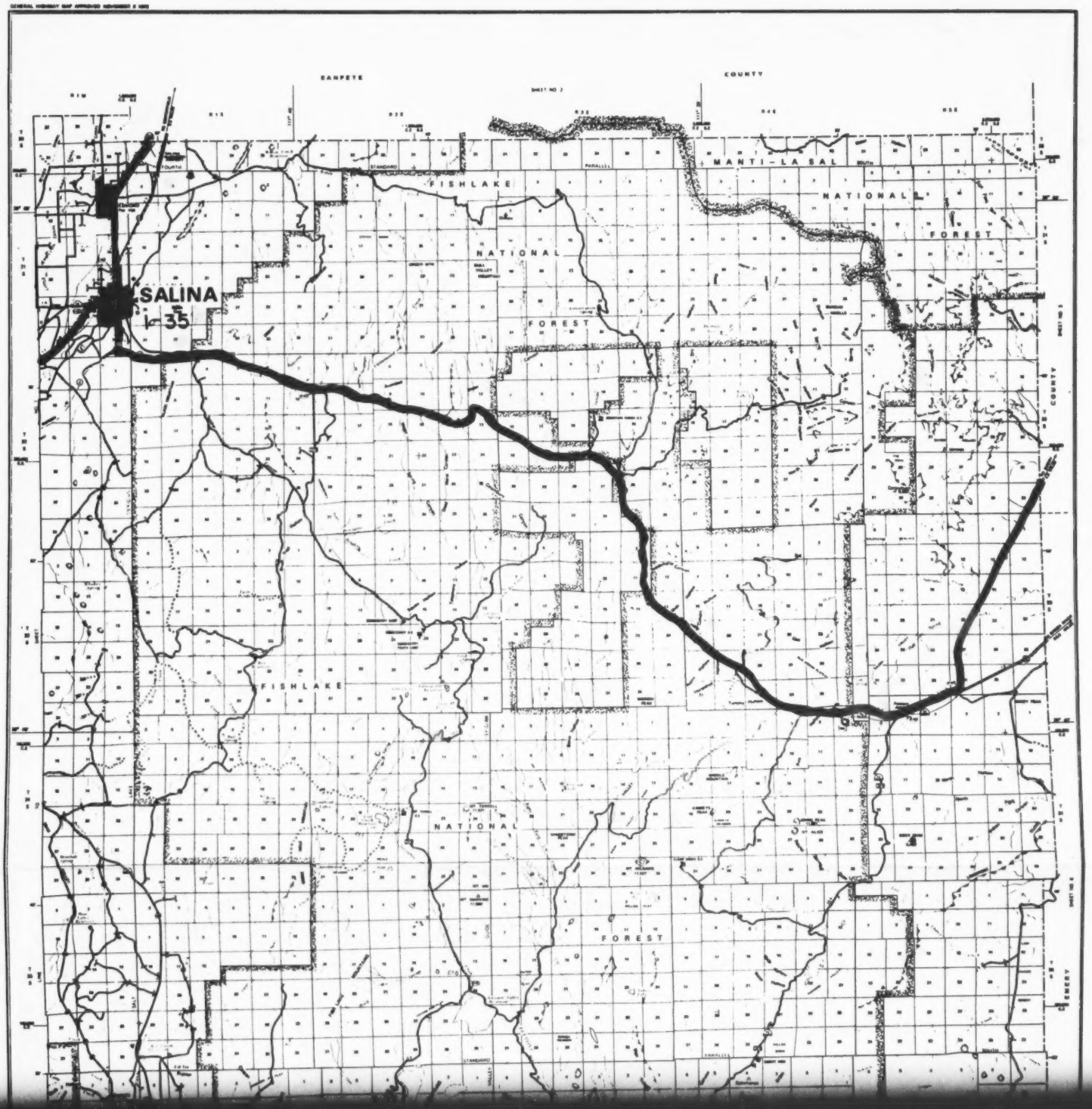
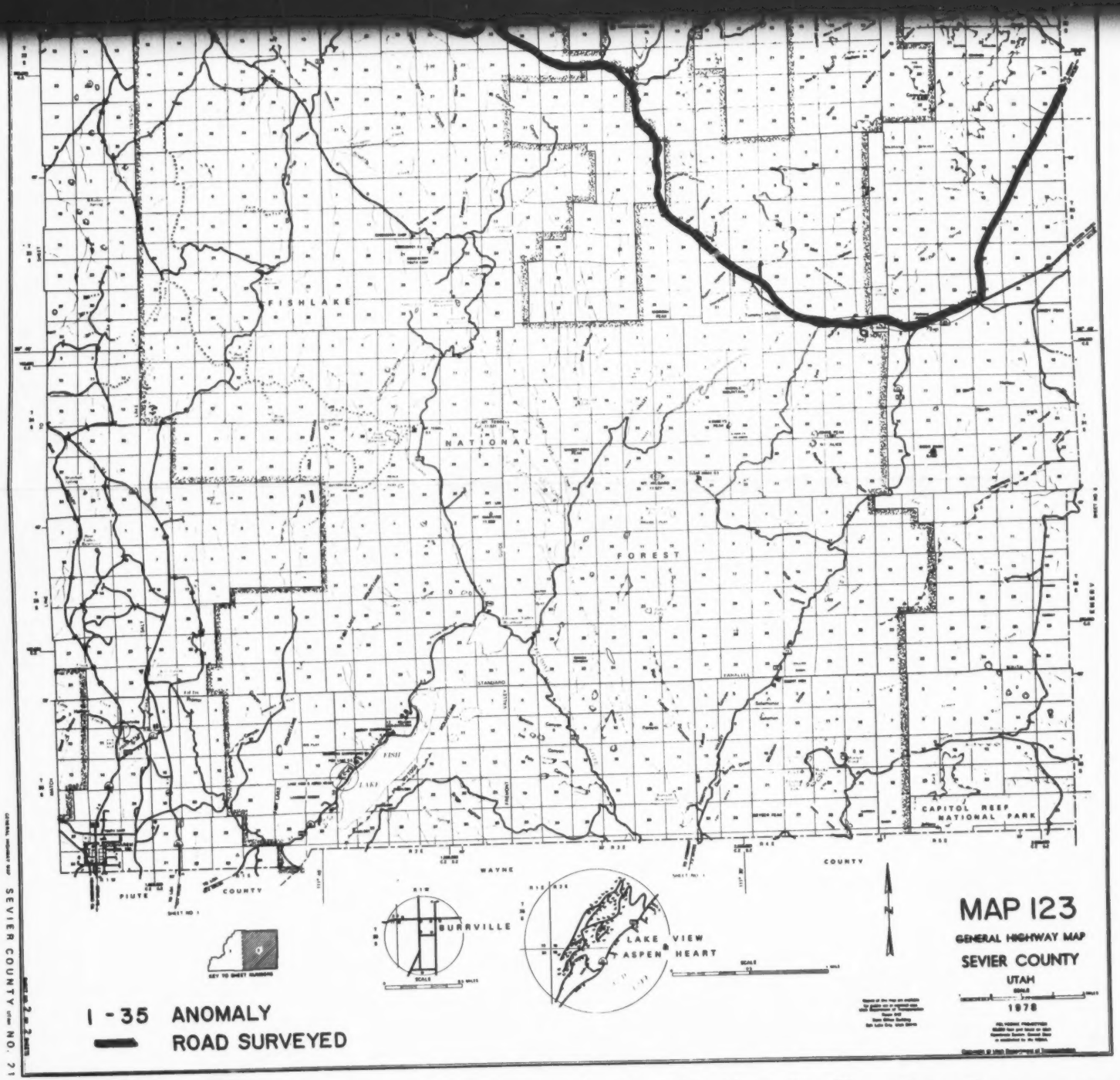

SANPETE
COUNTY
SHEET NO. 2
SALINA
I-35
FISHLAKE
NATIONAL
FOREST
MANTI-LA SAL
NATIONAL
FOREST
FISHLAKE
NATIONAL
FOREST
COUNTY
SHEET NO. 1
EMERY



Reproduced from best available copy.

Figure B16. Sevier County, Map No. 123, Chart No. 95

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36-139 ANOMALY
ROAD SURVEYED
MINE
MAP 124
GENERAL HIGHWAY MAP
SEVIER COUNTY
UTAH
PREPARED BY THE
UTAH DEPARTMENT OF TRANSPORTATION
TRANSPORTATION PLANNING DIVISION
PLANNING STATISTICS SECTION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
1978
CENTRAL
SEVIER COUNTY
SANPETE COUNTY
WILLARD
COUNTY
FISHLAKE
NATIONAL
FOREST
AURORA
39-46
47-128
RICHFIELD
129-132
133-138
SEVIER
RIVER
WILLARD
COUNTY
FISHLAKE
NATIONAL

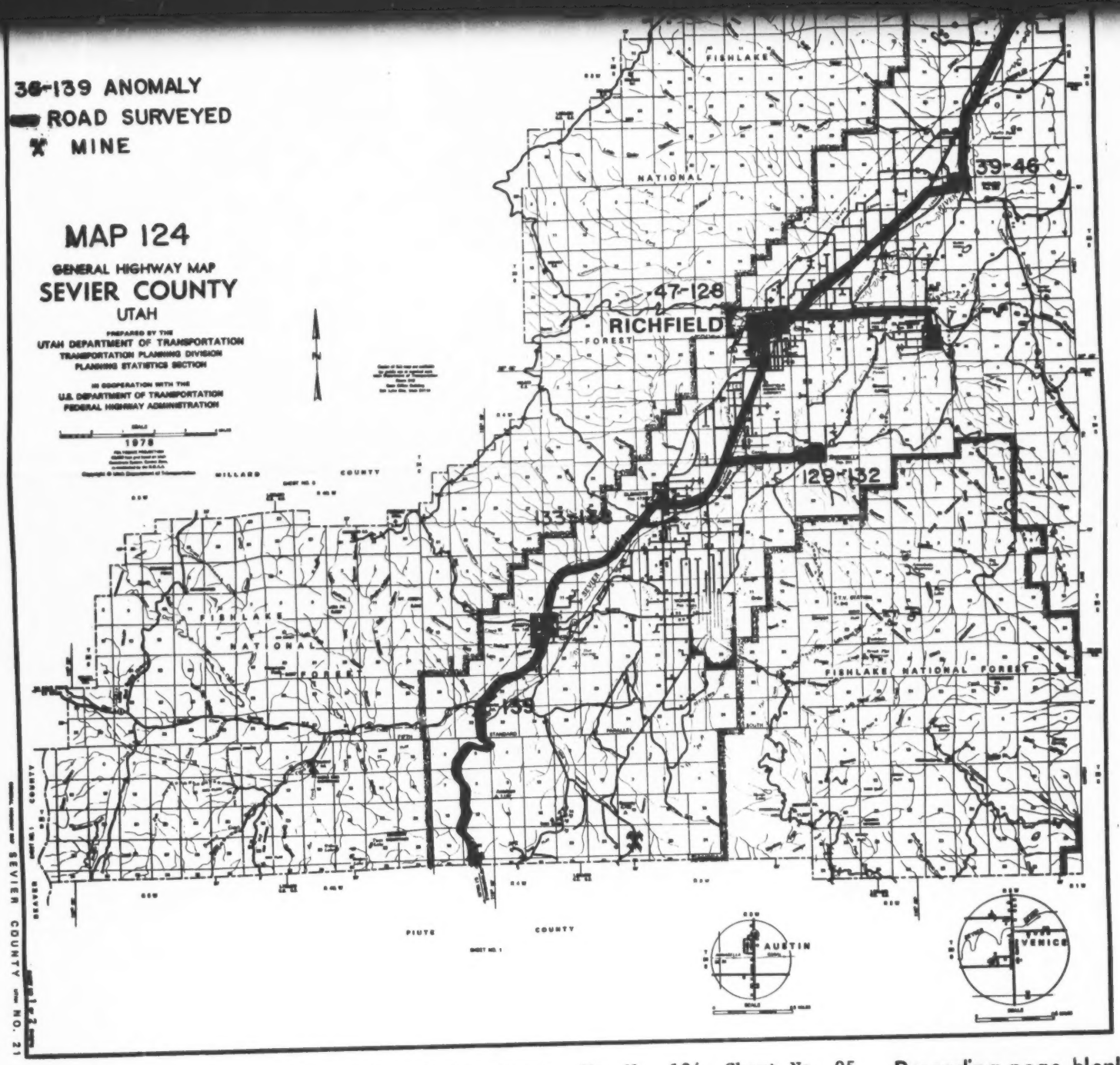

Figure B17. Sevier County, Map No. 124, Chart No. 95

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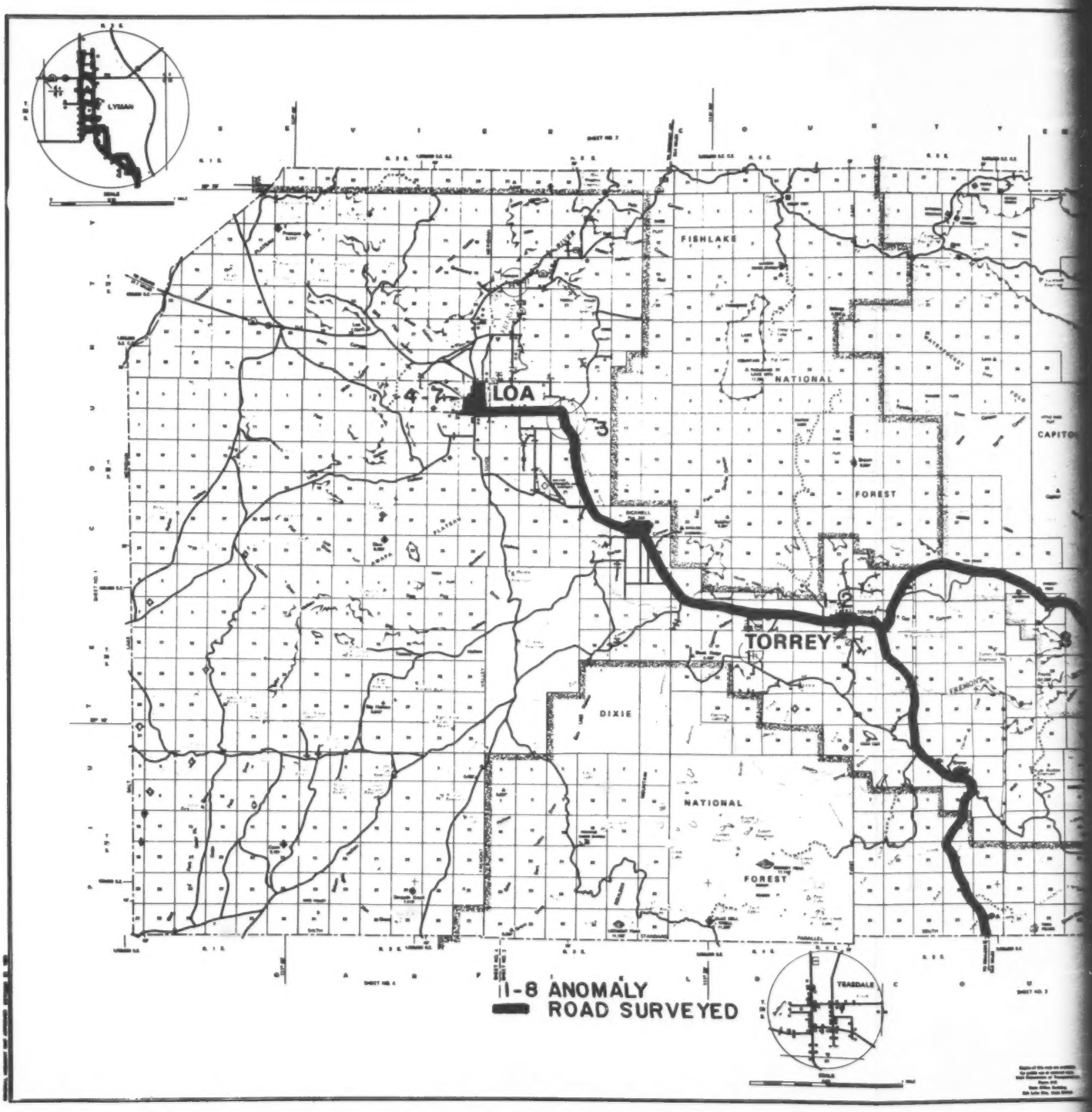

Figure B18. Wayne County, Map No. 128, Chart No. 98

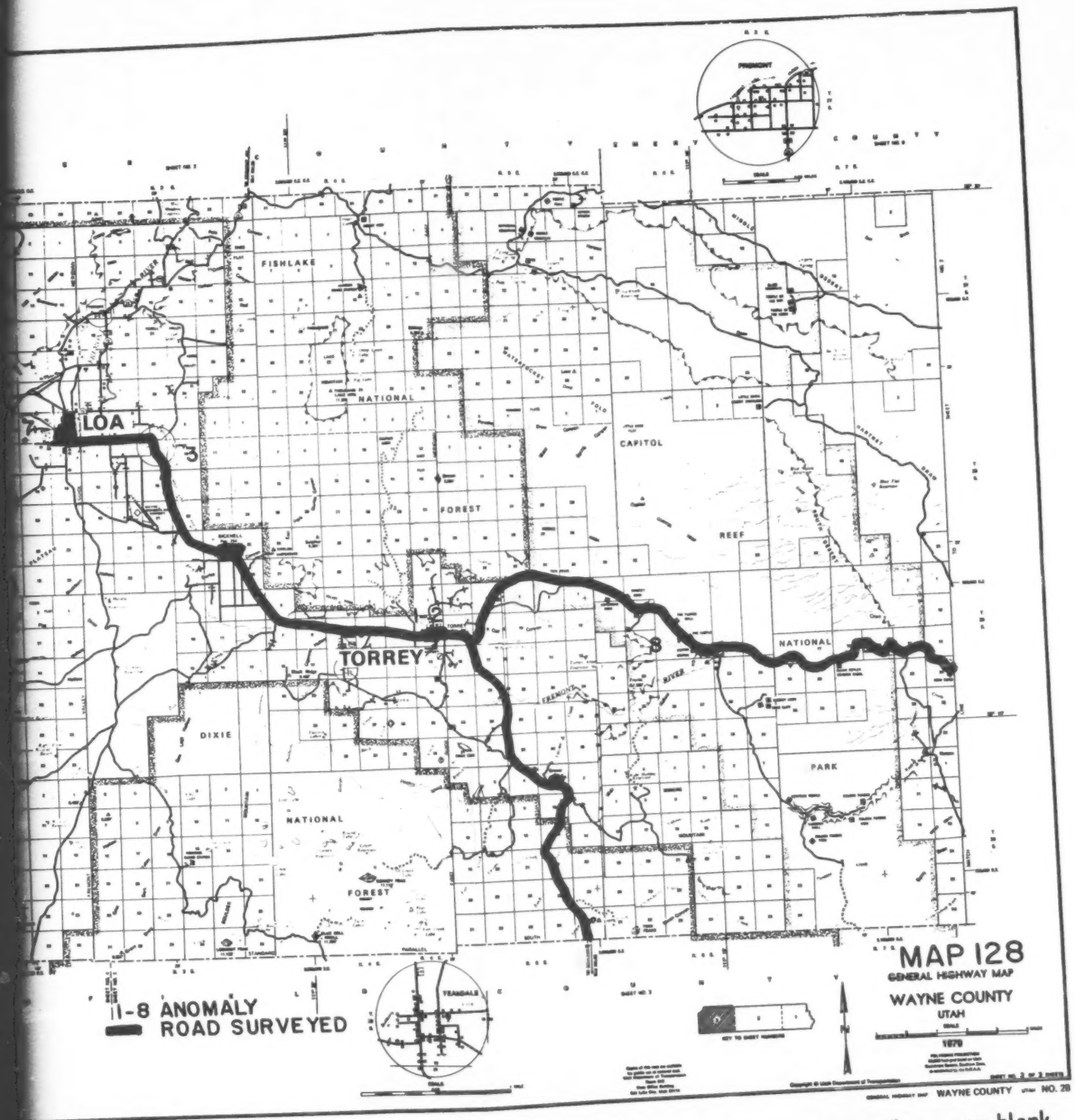

Figure B18. Wayne County, Map No. 128, Chart No. 98

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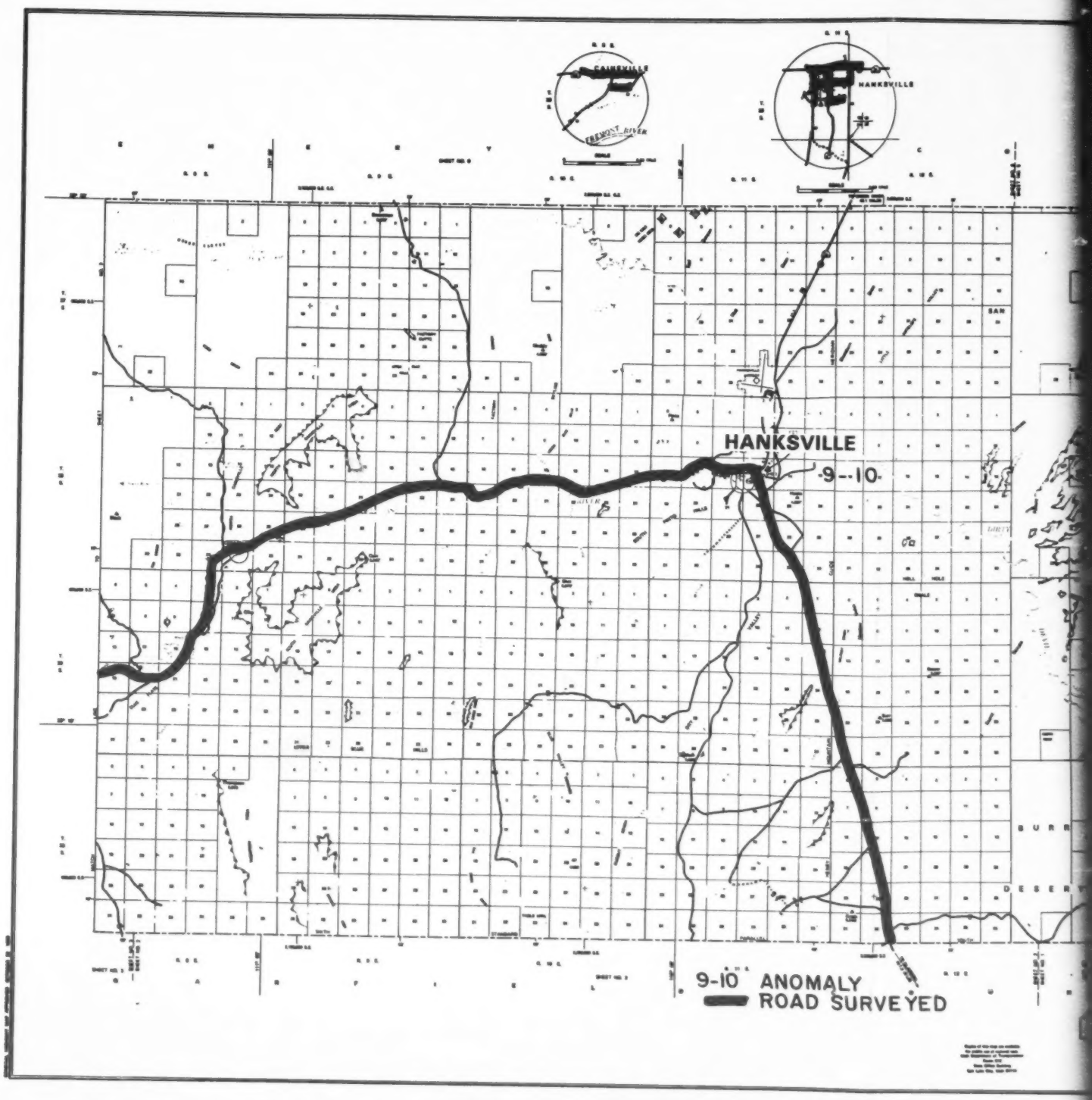

Figure B19. Wayne County, Map No. 129, Chart No. 98

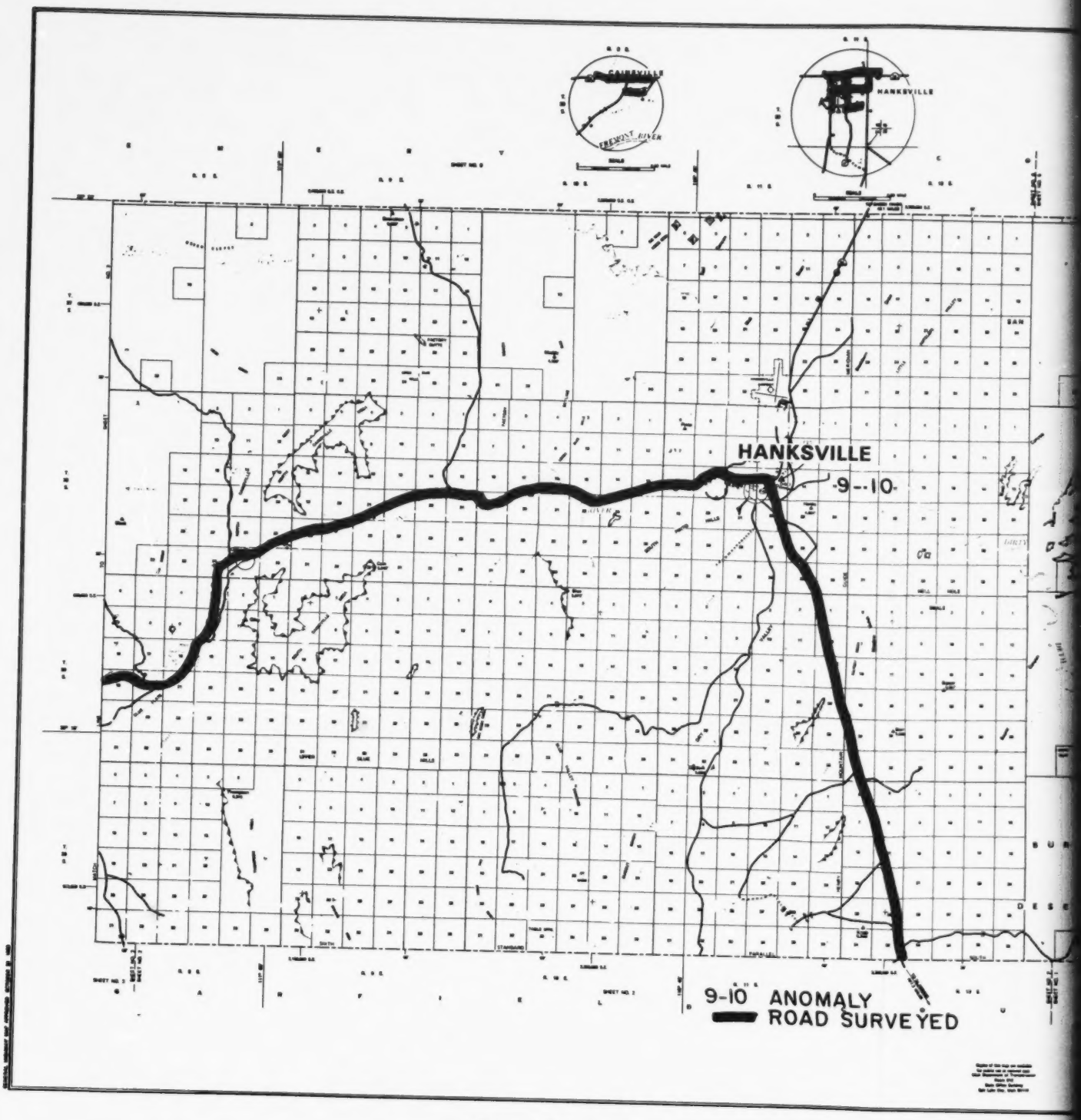

Figure B19. Wayne County, Map No. 129, Chart No. 98

Reproduced from best available copy.

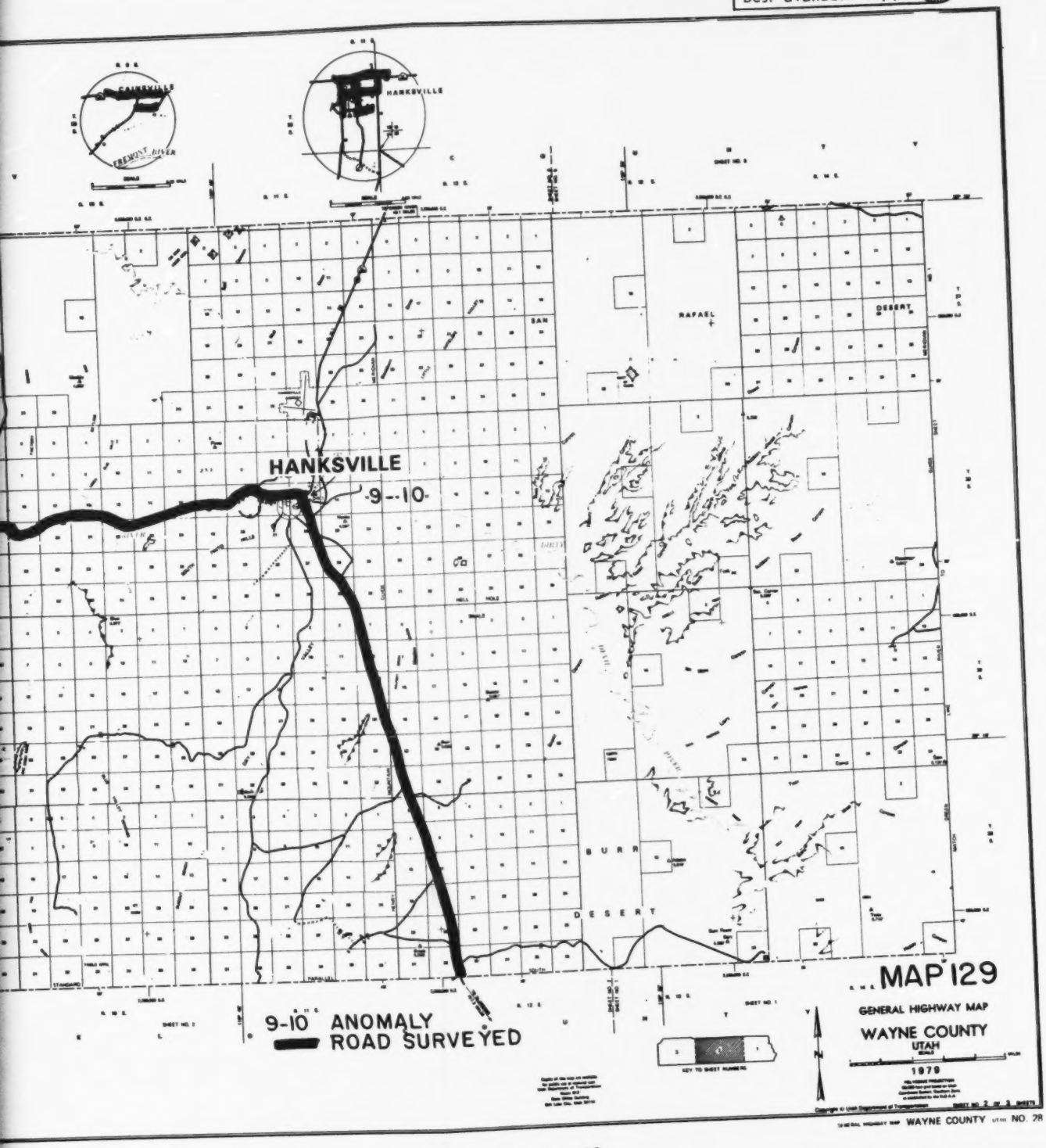

Figure B19. Wayne County, Map No. 129, Chart No. 98

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APPENDIX C

STRUCTURE SURVEY FORM

A special form, called the EPA Structure Survey, was created for use in the follow-up surveys requiring indoor working level measurements. On the back of the form, a grid was available for sketching the structure layout and radiometric (PIC and/or scintillometer) measurement points. This appendix contains a sample of the form (Figure C1) and an explanation of each entry. Although no indoor working level measurements were collected in the Utah Survey, the form is presented as one method of recording grab-sample information.

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EPA STRUCTURE SURVEY

Bendix Field Engineering Corporation
Grand Junction Operations
P.O. Box 1569
Grand Junction, CO 81502

NAME: _____ CITY/COUNTY: _____ DATE: _____

ST. ADDRESS: _____ STATE: _____ MONITOR: _____

		FILTER						FLASK										
Location / Condition	Date	Pump # / Roto Rdg	Flow L/M / Sample Weight	Counter # / Eff	Start of Min / Count started at Min	Counts	WL	Flask # / Counter #	Date Counted	Time Collected / Count Mid time	# of Hrs. Decay	Sample Counts	Count time / Bkg Count Time	Bkg/Min	pCi/L	± 1σ	% Equilibrium	Annual Ave. WL
												Ave.						
												Ave.						
												Ave.						
												Ave.						
												Ave.						

Comments _____

Kusnetz Factor					
40	148	62	104	84	67
42	144	64	100	86	64
44	140	66	96	88	62
46	136	68	92	90	60
48	132	70	88		
50	128	72	86		
52	124	74	83		
54	120	76	80		
56	116	78	76		
50	112	80	73		
60	108	82	70		

Decay Factor	
Hours	Factor
3	0.9776
4	0.9702
5	0.9629
6	0.9557
7	0.9485
8	0.9414
9	0.9343
10	0.9272
11	0.9203
12	0.9133

$$\% \text{ Eff} = \frac{\text{CPM}}{\text{DPM}}$$

$$\text{AltA} = \sqrt{\frac{29.92}{29.92 - \frac{\text{Alt}}{1000}}}$$

$$\text{Flowrate} = \text{Roto Rdg} \times \text{CF} \times \text{AltA}$$

$$\text{WL} = \frac{\text{CPM}}{\text{EF} \times \text{Sampling Time} \times \text{Flowrate} \times 148}$$

$$\pm 1\sigma = \sqrt{\frac{\text{Total bkg counts}}{\text{Bkg Counting time}} + \frac{\text{Total Source Count}}{\text{Source Counting Time}}} = \pm \text{CPM}$$

$$\frac{\pm \text{CPM}}{\text{Net CPM}} = \pm \% \text{ Error} \qquad \pm \% \text{ Error} \times \text{pCi/L} = \pm \text{pCi/L}$$

$$\text{pCi/L} = \frac{\text{Net CPM}}{4 \times \text{Volume} \times \text{Decay Factor}}$$

$$\% \text{ Equil} = \frac{\text{WL} \times 100}{\text{pCi/L}}$$

Figure C1. EPA Structure Survey Form

EPA STRUCTURE SURVEY (FIGURE C1) - ENTRY EXPLANATIONS

Location/Condition - where the sample was taken in the structure; wind speed, wind direction, and any other condition influencing results.

Time of Day (TOD) - use 24-hour clock notation: hour, minute, and seconds (e.g., 08:14:36), represents start of sample time.

Rotometer Reading (Roto Rdg) - air flow through the rotometer as read through the center of the ball.

Rotometer Correction Factor (CF) - the CF value is available off the rotometer, and is derived from a wet-test meter calibration.

Barometric Pressure (Bar Press) - as read from a barometer uncorrected for altitude.

Flow Rate - where:

$$\text{Flow Rate} = (\text{Roto Rdg}) \times (\text{CF}) \times \sqrt{\frac{29.92}{\text{Bar Press}}}$$

Source C.P.M. - the value obtained by dividing the total counts from the check source by the counting time period (in minutes).

Disintegrations per Minute (Source DPM) - value stamped on the check source.

Efficiency Factor (EFF) - where:

$$\text{EFF} = \frac{\text{Source CPM} - \text{Counter Background CPM}}{\text{DPM}}$$

Counter Background (Counter BKG) - the value obtained by dividing the total counts from an empty filter carrier by the counting time period (in minutes).

TOD Start Sample Count - time of day at the start of the 10-minute sample count.

Sample Count - number of counts recorded from the filter sample.

Sample Count Time - total time the filter sample was counted (10 minutes).

Working Level (WL) - where:

$$\text{WL} = \frac{\text{Sample Count} - \text{Counter BKG}}{\text{K(Kusnetz Factor)} \times \text{EFF} \times \text{Sample Count Time} \times \text{Flow Rate}}$$

Cell Number - a number stamped on each radon cell.

Cell Factor - a value identified on each cell to correct for cell efficiency.

Cell Volume [Cell Vol (1)] - a volume identified on each cell.

TOD Start Cell Count - time of day at the start of the cell count.

Sample Count Med Time - time of day the cell count is halfway completed.

Radon Decay Factor - values are available from the table at the bottom of the form, interpolate for uneven hour values.

Sample Count - number of counts recorded from the cell sample.

Sample Count Time - total time the cell sample was counted.

Cell Background CPM (Cell Bkg CPM) - the value obtained by dividing the total counts from the empty cell by the counting time period (60 minutes).

Radon pCi/l - where:

$$\text{Rn pCi/l} = \frac{\left(\dfrac{\text{Sample Count}}{\text{Sample Count Time}}\right) - \text{Cell BKG CPM}}{\text{Cell Factor} \times \text{Cell Vol (l)} \times \text{Radon Decay Factor}}$$

Percent Equilibrium (% Equil) - where:

$$\text{\% Equil} = \frac{\text{(WL)} \times 100}{\text{Radon pCi/l}}$$